IMPERIAL BUREAU OF MYCOLOGY

REVIEW

OF

APPLIED MYCOLOGY

VOL. I NOVEMBER 1922

GRAM (E.) & ROSTRUP (SOFIE). **Oversigt over Sygdomme hos Landbrugets og Havebrugets Kulturplanter i 1921.** [Survey of the diseases of cultivated agricultural and horticultural plants in 1921.]—*Tidsskrift for Planteavl*, xxviii, 2, pp. 185–246, 1922. [English summary.]

The period under review (1st October, 1920, to 30th September, 1921) in Denmark had an unusual amount of sunshine, a mild winter being followed by an exceptionally warm spring and a cool June. The rainfall was very low, except in December and January. The fungous diseases are classified under the following headings, many other records being given besides those mentioned below:—

CEREALS. Root blight (*Pythium de Baryanum* and *Fusarium* spp.) occurred in conjunction with poor germination in some oat and barley fields; oats (especially grey) were severely attacked, particularly on newly-tilled, non-calcareous soil. Mildew (*Erysiphe graminis*) occurred on rye, wheat, and barley, the new wheat variety Trifolium 14 being badly damaged. Foot rot (*Fusarium culmorum* and other species) was very prevalent on rye, wheat, oats, and barley. The strawbreaker fungus (*Leptosphaeria herpotrichoides*) caused some cases of foot rot of rye. Stripe disease of barley (*Pleospora graminea*) occurred in a comparatively mild form, but was very widespread, especially on the varieties Karl, Tystofte Prentice, and Nord Slesvig Kaempe. Good results were obtained by seed disinfection with 0·25 per cent. uspulun (which also promotes germination), 0·2 per cent. formalin, and 0·5 per cent. copper sulphate. Leaf spot disease of barley (*Pleospora teres*) was injurious chiefly on cold soils. Oats were attacked by leaf spot disease (*Helminthosporium avenae*) and winter barley by *Marssonia secalis*. Bunt of wheat (*Tilletia caries*) was very prevalent, 75 per cent. and 78·6 per cent. of infection being counted in two instances where the seed was not treated. Smut of wheat (*Ustilago tritici*) occurred on Wilhelmina and on Argentine spring wheat. Loose smut of barley (*U. nuda*), covered smut of barley (*U. hordei*), and loose and covered smuts of oats (*U. avenae* and *U. levis*) were all reported, the last named being on the increase owing to the

omission of seed treatment. Flag smut of rye (*Urocystis occulta*) was very common, but easily controlled by disinfecting with formalin. Black rust (*Puccinia graminis*) occurred on rye and oats in the vicinity of barberry bushes; the regulations concerning the eradication of the latter have now been extended to include the southern Jutland districts. Yellow rust (*Puccinia glumarum*) was very prevalent on wheat, especially Wilhelmina, Tystofte Small II, and Panser II.

LEGUMINOSAE. Mildew of peas (*Erysiphe pisi*) was very severe in August: marrowfats were mildly attacked by foot rot (*Fusarium*, etc.).

ROOT CROPS. Mosaic, rust (*Uromyces betae*), and downy mildew (*Peronospora schachtii*) on mangolds and beets are increasing, the reason given being that seedsmen's nurseries afford numerous opportunities of early infection. Crown gall (*Bacterium tumefaciens*), dry rot (*Phoma betae*), and *Hypochnus violaceus* all occurred on beets. Dry rot frequently appears as the result of fertilization with marl or lime, and *Hypochnus violaceus* is reported chiefly from low-lying swampy ground.

CRUCIFERAE. Black rot (*Pseudomonas campestris*) and *Mycosphaerella brassicicola* of cabbage and soft rot (*Bacillus carotovorus*) of turnips were prevalent. Records of several others common diseases of crucifers are given.

POTATOES. Leaf roll occurred very generally, Magnum Bonum being attacked to the extent of 75 per cent. in some cases. Mosaic was also very serious, especially on Up-to-Date. Blackleg (*Bacillus phytophthorus*) [*B. atrosepticus*] was severe on Sharpe's Victor and Richter's Imperator, and *Verticillium albo-atrum* on Up-to-Date.

FODDER CROPS. Clover stem rot (*Sclerotinia trifoliorum*) was adequately controlled by the application of lime or marl to the soil. Bacteriosis (*Aplanobacter rathayi*) of cock's-foot grass [*Dactylis glomerata*] was of some importance in the nursery districts, and there were a few insignificant attacks of *Epichloe typhina* on the same host. Smut of brome grass (*Ustilago bromivora*) was successfully controlled by formalin.

FRUIT. American gooseberry mildew (*Sphaerotheca mors-uvae*) can be controlled by cutting back the twigs and by delayed dormant spraying with copper sulphate 3 to 4 per cent. or formalin 2 per cent. A reduction in the use of nitrogenous fertilizers is also advisable. Tomatoes were attacked by streak (*Bacillus lathyri*) and a fusariose (*Fusarium culmorum*). Apple mildew (*Podosphaera leucotricha*) was widespread on the varieties Aakero, Baldwin, Bellefleur de France, Bismarck, Boiken, Cox's Orange, Signe Tillisch, Urania, and others. Canker (*Nectria galligena*) was most severe on Cox's Orange and White Transparent. Scab (*Venturia inaequalis*) occurred principally on Bismarck, Cellini, Cox's Orange, Cox's Pomona, Lord Suffield, etc. The trellis rust of pears (*Gymnosporangium sabinae*) was prevalent and more severe than usual.

CUCURBITACEAE. Mildew (*Erysiphe cichoracearum*) and blight (*Macrosporium melophthorum*) [*Cladosporium cucumerinum* Ell. & Art.] of cucumbers caused considerable losses.

ONIONS AND LEEKS. Onion mildew (*Peronospora schleideni*)

may be controlled by the careful selection of setts, roguing of diseased plants, and spraying with Bordeaux mixture. Onion mildew is reported for the first time on leeks. Leek rust (*Puccinia porri*) was also recorded from the north of the country.

TREES, SHRUBS, AND ORNAMENTAL PLANTS. A *Phoma*, found previously on allied evergreens, is reported to occur on dying twig-ends of *Cupressus*. *Fusarium dianthi* was found on carnations, streak (*Bacillus lathyri*) on sweet peas, and bacteriosis (*Pseudomonas syringae*) on lilac. Heart rot (*Polyporus annosus*) spread from fence posts to hawthorn and other shrubs in the vicinity and killed them.

PHYSIOLOGICAL. Bitter-pit was rather common in apples after picking. The appearance of dry spots and withering of the margin of apple leaves appears to be connected with a deficiency of potassium. A bark-burn ('*Lohkrankheit*') of cherry twigs was reported for the first time. Spray injury from lime-sulphur 1 : 30 is recorded on the apple varieties Frogmore Prolific (serious) and Hawthornden (slight). Yellow Transparent gooseberries are also liable to spray injury.

FREEMAN (E. M.). **Division of Plant Pathology and Botany.**—*Ann. Rept. Agric. Exper. Stat. Univ. of Minnesota*, xxix (1st July 1920 to 30th June 1921), pp. 72–77, 1921.

The most destructive plant disease in the State during the period under review was the black stem rust of wheat [*Puccinia graminis*]. Scab [*Gibberella saubinetii*] was also fairly serious, but less prevalent than in some years. Apples were severely attacked by fireblight [*Bacillus amylovorus*] and apple scab [*Venturia inaequalis*]. Blackleg of potatoes [*Bacillus atrosepticus*] did considerable damage in the Red River Valley, while lettuce drop [*Sclerotinia libertiana*] was quite destructive in the head lettuce region near Duluth, and black rot of cabbage [*Pseudomonas campestris*] in the south-east.

The work of breeding cereals for rust resistance is making progress. Selections from crosses between Marquis and Iumillo wheats were extremely resistant in the field. Preliminary experiments on the relation between soil nutrients and the physiology of host plants indicate that different biologic forms vary in their reaction to environmental conditions. There seems to be strong evidence that the spring habit of Marquis can be combined with the rust-resistant properties of Kanred. The study of the biologic specialization of cereal rusts has shown that there are at least thirty-three distinct forms of stem rust. Considerable evidence has been collected to the effect that the summer spores of black stem rust do not live over winter and spring in Minnesota, and that the rust in spring originates chiefly on infected barberries. The barberry eradication campaign has been vigorously pursued, twelve counties now being practically free.

The superiority of flax selections 25–7 and 175–1 was again demonstrated, these varieties being resistant to wilt [*Fusarium lini*]. Contrary to the general opinion, the wilt-resistant flax has not forfeited any appreciable degree of immunity by growing on

clean soil. Experiments indicate that early planting will aid in the prevention of wilt.

The foot and root rot and seedling blight of wheat, barley, and rye [*Helminthosporium* spp.] were further investigated, a marked difference in susceptibility being found in seed-clean varieties. Re-cropping of wheat grown in infected soil resulted in stunting of the plants. A strain of *Helminthosporium* isolated from rye infected 32 varieties of wheat, 10 of barley, 1 of rye, and 50 species of grasses, while 7 varieties of oats and 13 species of grasses proved immune.

Careful hand inoculations were made with a view to ascertaining the varietal susceptibility of wheats to loose smut [*Ustilago tritici*] and a high percentage of infection was obtained on Preston, Bluestem, Glyndon, and Marquis. Stanley was less susceptible and Mindum and Kubanka very resistant to this fungus. In the barleys Manchuria, Minnesota 388, and Wisconsin No. 9 were extremely susceptible to *U. nuda*, while Minnesota 184 was somewhat resistant.

Many differences in resistance to bean anthracnose [*Colletotrichum lindemuthianum*] have been demonstrated, and at least two biologic forms of the disease isolated.

Seed potatoes derived from sprayed plants gave higher yields than those from unsprayed plants. Probably this difference was largely due to the repellent action of Bordeaux mixture on aphids, thus preventing infection by mosaic. Better results in the control of black scurf [*Rhizoctonia solani*] were obtained by treatment with corrosive sublimate (1 : 1000 for 1½ hours) than with formaldehyde or copper sulphate.

[BEWLEY (W. F.)]. **Report of the Mycologist.**—*Seventh Ann. Rept. Cheshunt Exper. and Res. Stat. Hertfordshire*, pp. 32–41, 1921. [1922].

The following is a list of hitherto unreported diseases observed during the year. Tomatoes were affected by mosaic disease, and by a root rot and a fruit rot caused by *Sclerotium* sp. and *Botrytis* sp. respectively. Cucumbers were attacked by *Cladosporium* sp., causing leaf spot, and by mosaic disease. Arums suffered from a soft rot of the corms due to *Bacillus aroideae*, carnations were attacked by rust (*Uromyces caryophyllinus*), while wilt (*Verticillium albo-atrum*) was recorded on antirrhinum and sweet peas. Broad beans, culinary peas, and clover were all affected by streak (*Bacillus lathyri*).

The main problem under investigation was the leaf spot of cucumber caused by *Colletotrichum oligochaetum*. The symptoms of the disease and the characters of the fungus are described.

An attack on the leaves only impairs the health of the plant indirectly by the reduction of the leaf area, but when the fungus invades the stem it kills the parts above the point of attack. The scorched appearance of the plants and the spotting of the leaves make the disease easily recognizable.

C. oligochaetum grows readily on artificial media and also on such substances as new and rotten wood, straw, and cotton wool, if kept damp. An examination of suspected materials definitely

proved that the fungus may hibernate in decayed wooden structures and may also be carried in straw manure. Fumigation with sulphur and spraying with cresylic acids do not always entirely destroy the fungus in greenhouses owing to insufficient powers of penetration. It was found that the disease could be produced by artificial inoculations between temperatures of 45° and 86° F., but most easily at about 75° F., the optimum temperature for cucumber cultivation. The disease could be materially checked by keeping the temperatures abnormally high or low. There was a marked relation between the amount of moisture in the air and the rate of development of the disease. With an average percentage humidity of 92 or 88 the disease appeared in three days; at 82 it appeared in four days; at 78 in five days; at 69 to 63 in six days; while inoculated plants exposed to a percentage humidity of 54 remained healthy. Excessive moisture in the houses therefore hastens the spread of the leaf spot.

The disease may be controlled to some extent by cleansing the houses during the winter with an emulsion of cresylic acid and soft soap (1 gall. of straw-coloured cresylic acid (97–99 per cent. purity) to 8 lbs. of pure potash soft soap) used at the rate of about one part in fifty parts of water. During the growing season promising results were obtained by the use of liver of sulphur and lime-sulphur, flour paste or casein being added as 'spreaders'. The following formulae have proved most satisfactory: (*a*) 5 lb. flour, 4 lb. potassium sulphide, 100 galls. water; (*b*) 5 lb. flour, 2 pints lime-sulphur, 100 galls. of water. To ensure complete efficacy these sprays should be used before the succulent petiole and stem tissues are attacked, as the disease is very difficult to check afterwards. The disease is extremely virulent and should be combated immediately it appears. Spraying, followed by the removal of spotted leaves, should be repeated at weekly intervals if necessary. The spray occasionally burns a young leaf or tendril; but the damage done to the plant is negligible. Dusting with sulphur powder acts as a temporary check to the disease, but does not completely control it. The atmosphere of the houses should never be allowed to become stagnant or saturated with moisture, the beds should be kept warm, and the day and night temperatures maintained as nearly as possible equal.

'Damping off' and 'foot rot' of tomatoes, due to *Phytophthora cryptogea* and *P. parasitica*, were described in the fifth Annual Report. Sterilization, with 2 per cent. formaldehyde or heat, of the soil, seed boxes, pots, and water-supply, in all of which the causal organisms may be transmitted, has proved an effectual preventive of the disease. The so-called 'Cheshunt compound' consisting of a mixture of 2 oz. of copper sulphate and 11 oz. of ammonium used at the rate of 1 oz. to 2 galls. of water is effective in destroying the fungi in the soil without injuring the plant. It is very easy to use, being merely watered on the soil so as to wet it thoroughly. The compound has also been tested on tomato and other plants attacked by *Verticillium albo-atrum*, *Fusarium* sp., and *Rhizoctonia* with promising results.

Melon canker is a disease which generally appears when the plants are setting their first series of fruits, and the rotting of soft

tissues near the ground is a typical symptom. The base of the plant should be kept as dry as possible, and the rot may be checked by dusting the affected parts and adjacent soil with a mixture of two parts of finely ground copper sulphate, two parts of flowers of sulphur, and ten parts of powdered, dry, slaked lime. A bacillus has been isolated which is capable of producing the disease under favourable conditions and further work with it is in progress.

Mosaic is stated to be rapidly becoming one of the most important tomato diseases in the Lea Valley.

DICKSON (B. T.). **Plant diseases of 1920-21.**—*Thirteenth Ann. Rept. Quebec Society for the Protection of Plants*, pp. 66-67. 1921.

ORCHARD. During the season there was little apple scab (*Venturia inaequalis*) but an abundance of black rot (*Physalospora cydoniae*). The latter appears to be consequent on excessive winter injury due to the severe winter of 1917-18. Winter injury and black rot are two of the most important orchard problems of Quebec. Sporadic cases of silver leaf (*Stereum purpureum*) occurred.

FIELD AND GARDEN. Pea beans (*Phaseolus vulgaris*) were severely attacked by blight (*Pseudomonas phaseoli*), while mosaic and anthracnose also occurred, the latter only to a slight degree. Broad beans (*Vicia faba*) suffered from mosaic to the extent of 50 per cent. Sweet peas were also attacked by mosaic, distinct mottling being noticeable in the flowers of the red-purple varieties.

Clovers in general were subject to mosaic, the red clover (*Trifolium pratense*) in the experimental plots showing over 50 per cent. diseased. In the field, yellow and white sweet clover (*Medicago officinalis* and *M. alba*) were severely affected, and black medick (*M. lupulina*) and Alsike clover (*T. hybridum*) were also attacked, but no percentage estimates were made. Alfalfa (*M. sativa*) exhibited a speckling similar to that of mosaic, but it cannot yet be definitely identified as a form of the latter.

Tomatoes, potatoes, and tobacco all developed mosaic, the first named to the extent of 52 per cent. Mottling of the fruit was common. The potato seed was carefully selected, but nevertheless there was approximately 3 per cent. of mosaic, 5 per cent. of true leaf roll, and 8 per cent. of leaf roll caused by *Fusarium* sp. Blackleg (*Bacillus phytophthorus*) [*B. atrosepticus*] was not serious. Late blight (*Phytophthora infestans*) did not appear till September, when there was a fortnight of heavy, warm rain. This resulted in a heavy loss of potatoes in storage, chiefly from *Fusarium* rots combined with some late blight. The author's explanation is that the tubers did not mature sufficiently before harvest owing to warm rains in the latter part of the season, and very slight injuries to the skin can cause trouble in storage under such conditions.

Raspberries, especially Cuthbert, were severely attacked by curl and yellows, many plants showing typical mosaic symptoms with no sign of curl. Symptomatically they are distinct diseases. The uredo and teleuto stages of *Cronartium ribicola* again developed

on currants. This has occurred for the last six years, without any sign of a diseased *Pinus strobus* in the vicinity.

GREENHOUSE. As in the field, tomatoes, especially Livingstone Globe, and to a lesser degree John Baer, were attacked by mosaic. Leaf spot, caused by *Septoria lycopersici*, was not serious. Seedlings of *Chamaecyparis obtusa* and *Pinus koraiensis* were damped off by a *Fusarium*. Snapdragon rust (*Puccinia antirrhini*) became so serious that all old stock had to be discarded and new seed obtained.

STORAGE. Potato losses in storage have already been mentioned. Black rot in apples was fairly common, excellent mummies with pycnidia being obtained. Complaints were received from the Montreal market that apples were badly packed, with the result that the stalk of one apple pierced the skin of the one above, thus affording entrance to *Penicillium glaucum* which set up soft rot.

RAMIREZ (R.) **Plagas de la Agricultura en el distrito federal.** [Agricultural pests in the Federal District].—*La Revista Agricola* [Mexico], v, 9, pp. 662–663, 1921.

This is a list of the chief insect and vegetable parasites occurring in the Federal district, Mexico. The following are some of the records of parasitic fungi of interest. *Phytophthora infestans* on tomatoes; *Exoascus deformans* on apricots; *Pseudopeziza medicaginis* on alfalfa; *Thielavia* sp. on agaves; *Meliola camelliae* on limes and oranges; Erysiphaceae on vines, roses, begonias, dahlias, cucurbits, chillies, and beans; *Nectria* spp. on apple and pear trees; *Claviceps purpurea* on Gramineae; *Mycosphaerella fragariae* on strawberries; *Venturia pomi* [*inaequalis*] on apple; *V. pirina* on pear; another *Venturia* on figs; *Glomerella rufomaculans* on apple; *Oospora* [*Actinomyces*] *scabies* on sweet potatoes; *Botrytis* on vine; *Didymaria* sp. on agaves; *Dimerosporium agavectorum* on agaves; *Cercosporella* sp. on apple; *Coryneum beijerinckii* on apricots; *Cylindrosporium* sp. on apple; *Ustilago zeae* on Indian corn; *Ustilago tritici* on wheat; *U. nuda* on barley; *Tilletia foetans* and *T. tritici* on wheat; *Puccinia graminis* on wheat; *Phragmidium subcorticium* on roses; *Rhizoctonia* sp. on sugar beet and sweet potato; *Bacterium tumefaciens* on pear; *Bact. savastanoi* on olive; *Bacillus amylovorus* on pear, apple, and quince; *B. solanacearum* on sweet potato and tomato.

POLE EVANS (I. B.). **Botany and plant pathology: Annual Report Department of Agriculture for year ending June 30, 1921.**—*Journ. Dept. of Agric. S. Africa*, iv, 1, pp. 55–59, 1922.

The most important research work carried out by the Department was in connexion with the wastage in export citrus fruits [see this *Review*, i, 2, p. 58], citrus canker, and tobacco wildfire.

Steady progress has been made in the campaign against citrus canker, and the number of infected trees has dwindled from 11,702 in 1917–18 to 6 in 1920–21. The disease of tobacco known as wildfire [since found to be not true wildfire but angular spot: see next abstract] is very prevalent in the Pietersburg and Rustenburg

districts, and this serious disease is the subject of investigations with special regard to means of prevention. Poplar trees in the Bedford district have been found to be affected by *Cytospora chrysosperma*. A noteworthy feature during the late summer rains was the prevalence of bacterial diseases, particularly of the potato and tomato. Numerous inquiries were received concerning mottled or concentrically-zoned citrus leaves, a condition which requires physiological investigation. Crown gall seems fairly prevalent and must be attributed in part to the carelessness of nurserymen in sending out diseased stocks. Other diseases reported as being very prevalent were internal brown fleck and scab in potatoes, peach freckle, blossom end rot in tomatoes, wilt in pine seedlings, die-back of pines, ripe rot in papaws, die-back in apples, bacterial wilt of beans, walnut blight, physiological troubles of quince, plum, peach, pines, and buchu [*Barosma*].

At Durban further investigations of the micro-organisms causing deterioration of sugar in storage were carried out, and work on the South African Polyporaceae and Thelephoraceae was continued. At Capetown the study of the causes of wastage in export citrus made good progress and disclosed a very satisfactory state of affairs as far as cold storage conditions at Capetown are concerned; control of pear scab, of 'vrotpootje' in wheat, and die-back of stone fruit trees caused by *Schizophyllum commune* also engaged attention.

Departmental Activities. Wildfire and angular spot in Tobacco. *Journ Dept. of Agric. S. Africa.* iv, 2, p. 117, 1922.

The disease popularly known as wildfire and angular spot in tobacco, which during the season 1920–21 was only reported from the Government Experiment Stations at Rustenburg and Piet Retief and from certain farms in these districts, seems to be spreading to Groot Marico and Swaziland, while it has also made headway in the two original districts. This extension is causing great anxiety to growers.

According to Schilz's recent work, the South African organism is *Bacterium angulatum*, the bacterium connected with angular leaf spot in the United States. While the lesions on tobacco leaves in the field and those produced by inoculation resemble wildfire, the organism concerned is not the wildfire organism, *B. tabacum*, which has not once been isolated. [This is possibly also the case in Rhodesia: see this *Review*, i, 3, p. 93.]

HASKELL (R. J.) & WOOD (J. I.). **Diseases of fruit and nut crops in the United States in 1921.**—*Plant Disease Bull. Supplement* 20, 135 pp., 26 figs., 1922. [Mimeographed.]

The authors have prepared this report from data sent in by the working pathologists of the United States, most of whom are collaborators or correspondents of the Plant Disease Survey. Reports were also obtained from the Bureau of Markets and Crop Estimates. References are given to many of the publications of 1921 relating to fruit diseases in the country. The report covers diseases of pome fruits, stone fruits, small fruits, sub-tropical fruits

(including citrus, fig, date, pineapple, avocado, mango, papaw, and guava), and several nut crops.

The temperature during 1921 in the United States averaged above normal in all parts. The winter of 1920–21 was mild, and spring opened early, but was followed by damaging cold spells. Summer was characterized by unusual heat, with drought in many cases. The precipitation for the year was irregular, being below normal in many areas, but above normal in others. These weather conditions exerted considerable influence upon the occurrence and seriousness of various fruit diseases.

The diseases are listed under the name of the fruit affected, and for each disease there is a general survey of the prevalence and distribution during the year, followed by a more detailed survey by states.

These reports are invaluable to any one wishing to obtain a comprehensive picture of the injuries caused by plant diseases in the United States, and of the variation in these diseases from year to year.

Report of the College of Agriculture and the Agricultural Experiment Station of the University of California, 1st July, 1920 to 30th June, 1921. 191 pp., 1922.

This report contains a brief record of the work on phytopathology in progress at Berkeley, at the University Farm, Davis, and at Riverside, some of which has been separately noticed.

Field trials of large- and small-seeded Bayo beans for resistance and susceptibility to bean rust (*Uromyces appendiculatus*) showed that the large-seeded varieties are so far immune, while the small-seeded ones are susceptible with a single exception, which is extremely resistant if not entirely immune.

The following varieties of oats exposed to epidemic attacks of stem rust (*Puccinia graminis avenae*) were found to mature free from infection: Sixty Day (223a), Burt 253a, Nebraska 21, Richland (281a), White Russian (284a), North Black Finnish, Sixty Day Selections, C.I. 256, Wisconsin Pedigree Kherson 156, Iowa 25, Iowa 102½, and Iowa 96–3. Of these the three last named and White Russian all gave evidence of high resistance to stem rust under all conditions, while the character of early maturing was in some degree responsible for the immunity of the others. Greenhouse tests showed that, in addition to the varieties mentioned, the following were also highly resistant:—five strains of White Russian, Tartarian, Long Tartarian, Danish, and Ruakura. The results of inoculations with twelve strains of *P. graminis avenae* on a wide range of oat varieties gave no indication of the existence of more than one biologic strain on this host.

Observations were made on the factors influencing resistance to stem rust in wheat. In Kanred, a resistant variety, both morphological and physiological factors are apparently involved. The narrowness of the stomatal openings prevented the entry of all but 10 per cent. of the germ tubes, while the few which gained admission were immediately arrested by a reaction of the host resulting in the destruction both of the hyphae and the invaded host cells. The dead areas on the leaf cannot be seen without

a lens. In slightly less resistant wheats larger flecks of dead tissue may form before the fungus is killed.

Copper sulphate applied at the usual concentrations causes losses in steeped seed wheat under local conditions varying from 40 to 50 per cent., which may be largely prevented by dipping the seed thus treated in a solution of lime. This method is now well established in the Pacific coast states. During the past year nearly a thousand varieties and selections of wheat were heavily inoculated with bunt spores, and were grouped according to the results as follows: 0·7 per cent. immune (0 per cent. of infection); 1·9 per cent. resistant (0 to 10 per cent. of infection); 1·6 per cent. susceptible (11 to 25 per cent. of infection); 10·6 per cent. very susceptible (26 to 75 per cent. of infection); and 84·9 per cent. extremely susceptible (75 to 100 per cent. of infection). The immune and highly resistant wheats offer a basis for the breeding of bunt-resistant varieties. A number of crosses between resistant and susceptible wheats were made for future study.

Sooty mould (*Hormodendron cladosporioides*) occurs on wheat, and to a lesser extent on oats. Though usually considered unimportant it causes serious losses in the coastal districts subject to spring and summer fogs. The spores are wind-borne, the attack occurring after the grain is in full head. There appears to be a certain amount of varietal resistance to the disease. No remedy is known.

Barley scald (*Rhynchosporium secalis*) has been under observation in California for two years. It attacks the plants, especially the early sown varieties, soon after germination at the beginning of autumn. Some of the best varieties are highly resistant, while selections from Mariout, Tennessee Winter, and '4000' excelled the original parents in this respect.

Apple cankers were prevalent along the coast from Humboldt to Monterey, possibly because of their connexion with frost injury. The north-western and European cankers (*Neofabraea malicorticis* and *Nectria galligena*) were found together in several orchards, being hardly distinguishable from one another in the early stages. Reports from Oregon indicate that the treatment for north-western canker (Bordeaux 6–6–50 after the fruit is off, and again in three weeks) may also control European canker. New York canker (*Physalospora cydoniae*) was also present in a lesser degree.

Extensive experiments in the control of brown rot of apricots (*Sclerotinia cinerea*) were carried on at the Deciduous Fruit Station with some fifty different spray treatments, including most of the known fungicides. The preliminary results show that spraying has a definite value in controlling the disease. Even trees which only received a dormant spray (usually considered worthless) averaged fewer dead twigs than the controls. Ten large control trees averaged 299 infections to the tree, while ten similar adjacent trees sprayed with lime sulphur while dormant had an average of 183 infections, and ten other trees sprayed while dormant with Bordeaux only 102 each.

It was found that the common ornamental Japanese quince (*Chaenomelas japonica*) was an excellent host for *S. cinerea*. The quince flowers, which are amongst the earliest to come into bloom,

are readily attacked, the infected blossoms being densely covered with spore masses which serve to produce an early infection of susceptible fruit trees.

Bacterial gummosis (*Pseudomonas cerasus*) on the apricot is now reported to be present on the cherry also in California. The disease appears to be spreading rapidly. It is at times almost indistinguishable from brown rot.

The lemon brown rot fungus (*Pythiacystis citrophthora*) occasioned serious damage to deciduous nursery trees in the early winter. The heaviest losses occurred among June buds of peach and apricot, many trees being girdled by cankers just above the bud. Grafted stocks of pear, both Bartlett and Ussuriensis, were also affected. *P. citrophthora* is a soil fungus which attacks the bark only under conditions of extreme moisture, and no further spread is anticipated after planting out. There is some evidence, however, that the fungus may occur in bearing trees.

Fawcett's conclusion that *Bacterium citriputeale* Smith and *Bact. citrarefaciens* Lee, causing citrus black pit and citrus blast respectively, were identical, was confirmed by a number of experiments. The two diseases are merely two different effects produced by the same organism. It has also been ascertained that infections leading to the disease are usually due to slight surface injuries brought about by south winds with driving rain. This is the first satisfactory explanation of the well-known facts that the lesions are more numerous on the south than on the north side of the tree, and on long succulent shoots than on the shorter and more compact growth; and that the blast is slight on trees in sheltered places on the north side of buildings or thick hedges. Bordeaux mixture applied in the first few days of November reduced the number of blast lesions to about one-fourth of that on unsprayed trees.

Stem end rot and melanose (*Phomopsis citri*), not previously believed to occur in California, were found on lemons and pomelo respectively. The fungus has probably been present in the State for a long time but overlooked on account of its minor importance under Californian conditions.

WOLF (F. A.). **Additional hosts for Bacterium solanacearum.**—*Phytopath.*, xii, 2, pp. 98–99, 1922.

Some fifty species of host plants in nine families are known to be subject to attack by *B. solanacearum*. The author adds soybeans (*Soja max*), dahlia (*Dahlia rosea*), and cosmos (*Cosmos bipinnatus*) to the list of hosts found naturally infected. The dahlia and cosmos showed sudden wilting; but the soy-beans, although less wilted, showed a dwarfing followed by premature drying and death of the foliage.

HEUSER (W.). **Versuche über den Einfluss äusserer Bedingungen auf die Stärke des Steinbrandbefalls des Weizens.** [Experiments on the influence of external conditions on the intensity of bunt attack on Wheat.]—*Fühlings landwirtsch. Zeit.*, lxxi, 5–6, pp. 81–99, 1922.

Various external factors are involved in the incidence of bunt on wheat, the most important of which are temperature at sowing time,

and manurial treatment. Numerous investigations have shown that very high or very low temperatures favour the germination of the wheat at the expense of the bunt spores. On the other hand, the moderate temperatures usually prevalent in Germany at sowing time (6° to 10° C.) afford equal facilities of germination both to the grain and the spores. Laupert (*Deutsche landw. Presse*, lxii, 1920) states that in South Russia, wheat sown in the middle of August comes up in three to four days, before the spores have time to germinate. At very low temperatures again (3° to 4·5° C.), the spores are unable to germinate while the wheat can do so. The minimum temperature for the germination of wheat is 3° to 4·5° C. and for that of bunt spores 5° C., the optimum for wheat is 25° C. and for bunt spores 16° to 18° C., the maximum for wheat is 30° C. and for bunt spores 25° C. Rapid germination is also a varietal characteristic of Criewener 104, Siegerländer, and other varieties. Heine's Teverson is an example of a slow-germinating and slow-developing variety which is extremely liable to attack.

According to von Kirchner (*Fühlings landw. Zeit.*, 1916), the resistant varieties are enabled to withstand the progress of the mycelium, even after infection has taken place, by reason of certain acids, antitoxins, and ferments which they contain. The rapid development of the ears is a further means of protection against the disease, the mycelium being unable to penetrate all the newly-formed shoots. It is suggested that the anatomical structure of the hydrophytic varieties of the coastal districts is possibly better adapted to the requirements of the fungus than that of the xerophytic inland varieties. Small seeds used in an experiment gave a higher percentage of infection than large ones, but this is not of much importance in practice.

Fertilization with potassium and phosphoric acid increased the percentage of infection, while nitrogen reduced it by stimulating the development of ears. An experiment in 1921 showed that the use of seed from the 1919 crop led to a reduction of 20 per cent. in infection as compared with seed from the last harvest.

WEBER (G. F.). **Studies on Corn rust.**—*Phytopath.*, xii, 2, pp. 89–97, 3 figs., 1922.

Uredospores of *Puccinia sorghi* were found to germinate better when shaken from the sori than when removed with a scalpel. The minimum temperature for germination was 4° C., the optimum 17°, and the maximum 32°. The optimum temperature for infection was about 18° C.; a good deal occurred at 8°, but none at 32°. The germ-tubes enter the host through the stomata usually with, but sometimes without, the formation of appressoria. No attraction of the germ-tubes towards the stomata was found. The mycelium developed in the intercellular spaces in contact with the host parenchyma. Infection of the mesocotyl was obtained.

Uredospores from rusted maize leaves kept out of doors under various conditions at Madison, Wisconsin, in 1919, germinated freely until early November, after which a rapid decline in viability took place, and by 15th February, 1920, only two spores germinated in all the tests; after that none germinated. On 3rd and 11th January attempts to inoculate maize plants with these

spores from outdoors failed. The spores therefore failed to overwinter under such conditions.

No evidence of specialization on the part of the rust was obtained. Sweet corn (*Zea saccharata*) was found to be most susceptible to rust, followed in order by flint, flour, dent, *Z. ramosa*, pod, and pop corn, the last named being only moderately affected.

FITZPATRICK (H. M.), THOMAS (H. E.), & KIRBY (R. S.). **The Ophiobolus causing take-all of Wheat.**—*Mycologia*, xiv, 1, pp. 30–37, 1 pl., 1 fig., 1922.

Perithecia of *Ophiobolus* were found on wheat showing take-all symptoms in New York in 1920. The fungus was compared with specimens labelled *O. graminis* from England, Japan, Italy, and France, and all were found to be identical. Specimens were sent from New York to McAlpine in Australia, who pronounced the American material to be the same species as that occurring in Australia.

Comparisons were made between the specimens usually called *O. graminis* Sacc. and specimens of *Sphaeria eucrypta* Berk. & Br. and *S. cariceti* Berk. & Br. obtained from Kew. The latter is considered to be identical with *Ophiobolus graminis*, and the name *O. cariceti* (Berk. & Br.) Sacc. should replace *O. graminis*. *Sphaeria eucrypta* and *O. herpotrichus* are considered to be different organisms, both of which have, in various ways, been associated with the name *O. graminis* or with the take-all disease. A full description of *O. cariceti* is given.

KIRBY (R. S.). **The take-all disease of Cereals and Grasses.**—*Phytopath.*, xii, 2, pp. 66–68, 3 figs., 3 pl., 1922.

Take-all caused by *Ophiobolus cariceti* (*O. graminis*) was first reported for the United States by Kirby and Thomas from New York in 1920 (*Science*, lii, p. 368), and has since been found in Oregon, Arkansas, and Indiana. A survey of New York State in 1921 indicated that the disease was confined to winter wheats and was absent from the eastern part of the State. The loss was at least 2 per cent. in infected fields.

The disease is usually found in more or less circular areas, in which the plants are stunted and yellowish to ashy-white in colour. Infected plants usually die early and seldom produce more than a single head. The diseased culms are browned or blackened, from one-half to two inches above ground, by mycelium in the leaf sheaths and between the culm and inner sheath. The roots break readily, and there is a marked reduction of tillers. Later in the season saprophytic fungi may blacken the leaves and culms of diseased plants. After (or rarely before) the plants die, the beaks of the perithecia may protrude through the outer leaf sheath.

In the field the only plants attacked besides wheat were rye (a single plant) and *Agropyron repens*.

The cultural characters of *O. cariceti* are given. The fungus was isolated from ascospores, and perithecia developed in culture on sterilized sweet clover and wheat stems. Tests were made in the greenhouse by planting sixty-two varieties of cereals and forty-eight species of grasses in soil inoculated with the fungus. All the

fifty-four varieties of eight species of *Triticum* tested proved susceptible, nearly all the plants being stunted. Stunting of rye, oats, barley, maize, and most species of grass did not occur, although eventually the barley bore a pronounced mycelial plate with many perithecia at the base of the plants, and a few perithecia developed on rye. Of the wild grasses tested, very heavy infection occurred on *Agropyron repens*, heavy infection on *A. intermedium*, *Elymus canadensis*, *Hordeum jubatum* and *Hystrix patula*, moderate infection on eleven species, slight infection on eight species, and no infection on twenty-four species.

No conidial stage of the fungus was found. Ascospores are produced abundantly. They were found as early as 5th June, but during June and July the spores produced were shorter than normal, rarely septate, and failed to germinate. Ascospores kept under field conditions germinated during the period from October to March, but failed to germinate the following August.

Tests as to the method of dissemination of the fungus indicated that seeds from diseased plants do not carry the disease, that screened soil is infective for a time (less than eight months), and that bits of straw containing perithecia are most virulent, retaining their infective property for more than eight months. The soil is probably the principal source of the inoculum ; healthy plants grew beside diseased plants in pots without becoming infected.

The fungus grows better in an alkaline than in an acid medium. Tests showed that fewer plants were killed by it when sulphur or acid potassium phosphate was added to the soil than in the cases where lime or sodium nitrate was added.

In most fields examined, there was little or no difference in infection on high and low ground, although occasionally the disease appeared worse in wet soils.

Suggestions for control include rotation, the eradication of wild hosts from the fields, care in the use of manure containing infected straw, thorough cleaning of seed wheat, and the avoidance of liming the soil before planting wheat.

HORNE (W. T.). **A Phomopsis from the Isle of Pines.**—Abs. in *Phytopath.*, xii, 2, p. 105, 1922.

A *Phomopsis*, apparently more vigorous than *P. citri*, was obtained from a grapefruit from the Isle of Pines, West Indies, with stem end rot. The fungus was capable of producing typical stem end rot in oranges and grapefruit when inoculated from cultures.

BURGER (O. F.) & DE BUSK (E. F.). **Spraying to control melanose.** —*Univ. of Florida Agric. Exper. Stat. Press. Bull.* 335, 2 pp., 1922.

This is a preliminary report on the control of citrus melanose (*Phomopsis citri*). The disease is most prevalent in rainy and foggy seasons, when the spores of the fungus are washed from the dead twigs on to the leaves and fruit. The leaves and twigs can only be infected while very young, the disease being harmless to leaves of three to five weeks old or more. The leaves should therefore be sprayed very early. Recent experiments showed that the

disease can be controlled by spraying the trees from ten to twenty days after two-thirds of the blossoms have dropped. Good results were obtained by the use of the following Bordeaux-oil spray: copper sulphate 3 lb., rock lime 3 lb., water 50 galls., and a good oil emulsion 3 qts., the latter being added after the Bordeaux has been prepared.

A power sprayer with a pressure of not less than 200 lb. must be used (or 250 lb. in the case of a spray gun). The use of spray rods is recommended.

LUDWIG (C. H.). **The control of angular leaf spot of Cotton.**—*Phytopath.*, xii, 1, pp. 20–22, 1922.

During 1921 a second test of Rolfs and Faulwetter's method for the control of angular leaf spot of cotton (*Bacterium malvacearum*) was carried out at the South Carolina Experiment Station. The treatment consists in stirring the seed in strong sulphuric acid until the lint is removed, washing, sterilizing for about ten minutes in 1 in 1,000 solution of mercuric chloride, washing again, and drying. The seed used in the trial was of the Cleveland Big Boll variety, and was severely attacked by leaf spot. It was found that the disease was excluded from the plots planted with treated seed until the parasite had had time to enter from outside. In the untreated control plots the percentage of infection ranged from 24·2 to 85·3. Recent Arkansas observations indicate that the disease may be transmitted from infected to healthy fields by labourers passing from the one to the other. In the absence of infection from outside the treatment of the seed with sulphuric acid and mercuric chloride appears to give absolute control of angular leaf spot.

COOK (O. F.). **Causes of shedding in Cotton.**—*Journ. of Heredity*, xii, 5, pp. 199–204, 4 figs., 1921.

The shedding of floral buds and bolls is a consequence of abortion, the danger of which must be recognized in the breeding of varieties, as well as in the choice of cultural methods. While any injury to the buds or young bolls, or any external condition that inhibits their development, may be a cause of shedding, there is no doubt the primary causes are genetic and physiological. The normal method of shedding is by disarticulation, i. e. unjointing of the socket where the base of the pedicel is inserted on the fruiting branch. Lloyd's studies (Environmental changes and their effect upon boll-shedding in Cotton, *New York Acad. Sci.*, xxix, pp. 1–131, 1920) show the lack of a structurally specialized abscission layer, but this does not justify the statement that 'the position of the abscission layer is not predetermined by any anatomical relations, but is an expression of a purely physiological phenomenon'. On the contrary, it appears that abscission has a very definite morphological position, occurring always at the same place in the socket or insertion of the pedicel.

Considering that pedicels represent internodes, the sockets are the nodal points, where unspecialized, embryonic tissues would be expected. The articulation is marked on the surface by a minute groove, and by the absence of oil-glands from a short ring of nodal tissue.

With sockets of the normal circular, or transversely elliptical form, the pedicels often begin to tear at the base while the buds and their enclosing involucres are still fresh and turgid. The buds may wilt on partial detachment or fall with scarcely any sign of withering. A gap is at once formed between the separating tissues of the pedicel and the socket, this relaxation of tension indicating that the socket was too large for the base of the pedicel. In such cases enlargement of the sockets, rather than shrinkage of the pedicels, would seem to give the mechanical stimulus for shedding. The inhibition of the growth of the floral buds or young bolls during the development of the vegetative framework would explain the enlargement of the sockets in proportion to the pedicels. The growth of the fruiting-branch internodes must continue in order to support more internodes, buds, and bolls further out on the branch. Shedding of buds is much less frequent with Egyptian than with Upland cotton, but over-luxuriant conditions may force abortion even in the Egyptian type.

In certain cases the pedicel is not inserted on a normal rounded socket, but runs down the internode of the fruiting branch by a decurrent base. In such cases shedding is replaced by a condition of 'blasting' in which the withered buds may remain attached to the plant, simulating a disease. It is not a true disease, however, but due to a hereditary malformation of the pedicel.

The above observations do not detract from the importance of other causes of shedding such as mechanical injury, pests, diseases, and unfavourable climatic and soil conditions. According to Lloyd, shedding follows more rapidly and regularly upon mechanical injury than upon weevil attack. Excessive shedding in brachytic varieties is explained by the same authority on the basis of 'competition between bolls for water', but a genetic factor is clearly indicated, since one may find plants aborting all their buds while their neighbours yield good crops.

DOWSON (W. J.). **On the symptoms of wilting of Michaelmas Daisies produced by a toxin secreted by a Cephalosporium.**— *Trans. Brit. Mycol. Soc.*, vii, 4, pp. 283–286, 1922.

The present paper is an account of the experiments undertaken by the author at Wisley in the autumn of 1920 in the investigation of the secretion of a toxic substance by a fungus which causes a serious and widespread wilt disease of Michaelmas daisies, and which for the present is regarded as a species of *Cephalosporium*. The complete account of the investigation of the disease, including the morphology of the parasite, is left over for a further paper.

Distilled water containing aster stems was used for growing the fungus. After some weeks the liquid was filtered through a Berkefeld filter, and healthy shoots of Michaelmas daisy inserted in small glass bottles containing it. Controls of boiled tap-water were used. After three days the wilting was complete, the symptoms resembling those of the disease as induced by inoculating with the fungus. The controls remained unchanged for ten days.

In a second series the filtered fluid was dialysed through goldbeater's skin into boiled tap-water, and similar but even more rapid results were obtained.

In a third set of experiments mesophyll cells of healthy leaves were placed in hanging drops of the filtered liquid. Changes in the chloroplasts were noticed after twenty-four hours, and by the sixth or seventh day they were collected into an irregularly-shaped, bright yellow mass at one or both ends of the cells, while plasmolysis was setting in.

It is concluded that the symptoms of the disease are due to the action of a crystalloid toxin, secreted by the fungus, on the assimilating tissue. Resistant varieties were equally affected by the toxin, and are believed to owe their resistance to interference with the growth of the fungus.

WILTSHIRE (S. P.). **The Michaelmas Daisy disease.**—*Ann. Rept. Agric. & Hort. Res. Stat. Long Ashton, Bristol, for 1921*, pp. 74–76, 1 fig., 1922.

A number of inoculation experiments were carried out on stems of Michaelmas daisy plants in pots, the fungus used being in several cases the original strain first isolated from wilted plants at this station in 1920 (*Long Ashton Rep. for 1920*, pp. 84–85, 1921). The inoculations were done through stem wounds. The earliest symptom of infection was noticed from eighteen to thirty days after inoculating as a reddish-yellow discoloration of the leaves on the main stem of the inflorescence. This was followed by the withering of some leaves of the flowering shoots. The affected shoots were frequently confined to the side of the inflorescence above the inoculation. Ultimately the whole shoot died and young shoots sprang up from the base exactly as occurs in natural infections. A fungous mycelium similar to that used in the inoculations was recovered from the dead stems.

The fungus originally isolated is therefore the probable source of the disease, but it was decided fully to establish its pathogenicity before naming it. No differences between it and the fungus reported by Dowson in a similar disease [see last abstract] were apparent in an isolation of proved pathogenicity received from him.

CHABROLIN (M.). **Le dépérissement des Abricotiers dans la Vallée du Rhône.** [The dying off of Apricots in the Rhone Valley.]—*La Vie agric. et rurale*, xx, 24, pp. 415–416, 1922.

Various methods are being tested with a view to saving the apricot trees of the Rhone Valley, which have been dying in great numbers of recent years [see this *Review*, i, 6, p. 180]. The diseased condition is reported to be extending to fresh areas, which points to the spread of infection from affected trees. Dead trees should be removed immediately, and many growers recommend that any trees which shed their leaves prematurely or have yellow terminal shoots should also be cut out. The removal of affected branches is advantageous, provided the wounds are dressed with an antiseptic solution.

Attempts are in progress to raise trees from seed, but so far the results are not very encouraging. Treatment with a copper bouillie (Michel Perret 2 per cent.) gave good results in one case, but applications of a mixture made up with copper sulphate 2 kg., lime 1 kg.,

casein 50 gm., and water 100 litres, appear to have been useless against *Monilia*. Spraying with lime-sulphur is recommended.

BROOKS (C.), COOLEY (J. S.), & FISHER (D. F.). **Experiments on the use of oiled fruit wraps for the control of Apple scald.**—Abs. in *Phytopath.*, xii, 2, p. 103, 1922.

Further tests have confirmed previous results showing that scald can be controlled under the most unfavourable storage conditions by wrapping apples in paper infiltrated with oils which absorb the respiration gases. An odourless and tasteless type of oil has been found which does not cause any tainting of the fruit.

Scald can be arrested or reduced after several months' storage by substituting oiled paper for the common paper wraps, and it was also found that if the fruit was first stored in oiled paper, scald did not result when it was repacked in common paper after a month.

WILTSHIRE (S. P.). **Canker control trials.**—*Ann. Rept. Agric. & Hort. Res. Stat. Long Ashton, Bristol, for 1921*, pp. 70–73, 1922.

Further spraying trials were carried out in 1921 on a highly susceptible apple seedling, Kingston Black x Médaille d'Or. Owing to the abnormally dry summer, however, the amount of infection was very slight, which lessened the value of the tests. The first spraying, with copper stearate, was given on 3rd February, and a second, with Burgundy mixture, on 1st April. Ten shoots on each of five trees were sprayed, ten others being kept free from spray as controls. There were more cankers on the sprayed branches than on the controls (16 to 9), but the number in both cases was negligible as compared with 1920 (179 to 500 on a smaller number of larger branches). It is probable that a wet atmosphere is of even greater importance than wet soil conditions in the production of canker, though earlier experiments (of which details are given) have shown that the latter is an important factor, influencing both the number and the rate of growth of the cankers.

A further experiment was made on a large scale in a mixed plantation of young bush apples which were sprayed with Burgundy mixture in December 1920. The number of leaf-scar infections visible in November 1921 on both treated and control trees was small compared with that usual in a rainy year. One striking feature of this experiment was the number of cankers developing from old cankers imperfectly excised (seventeen in the sprayed trees and twelve in the controls). This emphasizes the necessity for thorough cutting out, the only really safe plan being to cut well into the healthy wood, in order to ensure complete removal of the fungus. Omitting cankers on the 1921 wood, there were 54 on the control trees (60 trees of 20 varieties) against 34 on the same number, of the same varieties, sprayed. Certain varieties were much more severely attacked than others.

WHITE (E. W.). **Apple tree anthracnose or black spot canker control.**—*Scient. Agricult. (Canada)*, ii, 6, pp. 186–191, 3 pl., 1922.

This disease [fungus not named, but presumably *Neofabraea*

malicorticis (Cord.) Jackson] is prevalent in the coastal regions of British Columbia. As a result of several years' experiments, the author finds that the disease can be controlled, and recommends pruning out all dead wood in July and August, and spraying early varieties with 3–4–40 [Imperial gallon] Bordeaux as soon as the fruit is picked. For medium late varieties, spraying with 1–1½–40 Burgundy in late August, and with 3–4–40 Bordeaux as soon as the fruit is picked, is recommended. For late varieties an application of 3–4–40 Bordeaux in late August is considered sufficient.

WORMALD (H.) & GRUBB (N. H.). **Notes on the control of nursery stock against crown gall.**—*Gard. Chron.*, lxxi, p. 198, 1922.

The results of experiments carried out at East Malling Research Station, on certain types of Paradise apple stocks known to be very susceptible to crown gall, may be summarized as follows: the galls occurring on the base of the stock were distinctly larger where the stocks had been roughly torn from the stools than where smoothly cut with a knife. Covering the wound, before planting, with Stockholm tar or grafting wax, especially the former, reduced the number and size of the galls but also appeared to injure the roots to some extent. Probably this was largely due to the poor rooting of these stocks. Stocks planted with their bark severely bruised showed after two years' growth a considerable proportion with galls on the main stem above the base, while uninjured stocks were practically free. Many of the cut roots bore small galls at the cut ends.

LEE (H. A.). **Banana freckle in the Philippine Islands.**—*Phytopath.*, xii, 2, pp. 101–102, 1 fig., 1922.

Green and mature banana fruits in public markets in the Philippines are commonly spotted with reddish-brown to black spots. The leaves may also show similar spots, and are often streaked and roughened by the disease. The spots bear pycnidia and the spores resemble those of *Phoma musae* Carpenter, as described from Hawaii. Attempts to culture the organism failed. The disease is much more abundant at the close of the wet than during the dry season. It is prevalent also in the Sulu Archipelago and in the island of Mindanao. It is considered probable that the disease reached Hawaii from the Philippines.

ZELLER (S. M.). **Die-back of Loganberry in the Northwest.**—Abs. in *Phytopath.*, xii, 2, p. 104, 1922.

Die-back was found where the canes were left hanging down during the winter, but not where they were trained up in the autumn. *Mycosphaerella rubina* is sometimes present, but it is considered that the canes are devitalized by the extremely moist conditions to which they are subjected during the winter, rather than by the effects of any parasitic organism or low temperatures.

SIEGLER (E. A.) & JENKINS (A. E.). **A new Sclerotinia on Mulberry.**—*Science*, N. S. lv, pp. 353–354, 1922.

Sclerotinia carunculoides n. sp. is described on fruits of cultivated *Morus alba* from Scranton, S. Car. The fungus produces

a disease characterized by the enlargement of portions of the fruit.

MAFFEI (L.). **Una malattia della foglia del 'Kaki' dovuta al Colletotrichum kaki n. sp.** [A leaf disease of the 'Kaki' due to *Colletotrichum kaki* n. sp.]—*Riv. Patol. Veg.*, xi, 9-10, pp. 116-118, 1921.

For some years past, a hitherto undescribed leaf disease of the persimmon has been observed in the Botanic Garden at Pavia on specimens of *Diospyros kaki* L. var. *kiombo.* In 1921 the disease appeared with particular virulence, scarcely a leaf being free from it. The author thinks that this outbreak may have been favoured by a hailstorm which injured the leaves in July that year. Other varieties of persimmon in the vicinity were not affected.

The disease is characterized by hazel spots originating nearly always at the margin or at the apex of the leaves, and progressing towards the centre with the formation of concentric rings. The major portion of the leaf is invaded, dries up, and becomes brittle, and the whole leaf finally falls. The spots stand out very vividly on the intense green of the leaf. As they increase and coalesce they alter the shape of the leaf and give it a contorted, almost knotty, aspect. In association with the concentric markings, numerous acervuli, varying from 90 to 160 μ in diameter, burst through the epidermis and liberate a great number of cylindrical, hyaline, granular, sometimes guttulate spores, 18 to 21 μ long by 4 to 7 μ broad, borne on densely crowded basidia. From the stromata stand out numerous, pointed, brown, septate hairs, 100 to 180 by 4·5 μ, which traverse the hymenial stratum.

The author proposes to call the disease 'kaki leaf spot', and the causal organism *Colletotrichum kaki* n. sp., a Latin diagnosis being appended. He is, however, doubtful whether it is distinct from *Gloeosporium kaki* Seiya Ito, which he found on the same plants.

CERASOLI (E.). **Intorno alla solubilizzazione dei composti cuprici anticrittogamici sulla superficie degli organi verdi della Vite.** [On the solubility of fungicidal copper compounds on the surface of the green portions of the Vine.]—*Riv. Patol. Veg.*, xi, 5-6, pp. 70-72, 1921.

There is a very complete literature on the effect of Bordeaux mixture on *Plasmopara viticola,* but nothing definite is known concerning the solubility of the small quantities of copper contained in fungicides after being deposited on the green portions of the vine.

It is generally known that carbonic acid, ammonium carbonate, and nitric acid, in variable quantities, are always present in the atmosphere and in rain-water, and that these exert a solvent action on copper compounds. It is further generally admitted that some effect in dissolving the copper particles is exercised by special substances secreted by the leaves, such as ammonium compounds and organic acids, but Ruhland has demonstrated that in a healthy leaf the quantities available are so small as to be without practical effect.

The author's investigations with Bordeaux mixture and Bordeaux

powder [see this *Review*, i, 3, p. 67] have led him to conclude that copper, under the influence of atmospheric factors, especially carbon dioxide, tends to become transformed into bicarbonate of copper, which would subsequently give rise to the formation of colloidal solutions of copper hydrate. Perhaps after a certain lapse of time and under favourable environmental conditions, the bicarbonates and the colloidal solutions of copper hydrate, combined in a certain chemical equilibrium, give rise to the formation of copper carbonates physically distinct from the ordinary carbonates, so that they cease to be influenced by the action of the carbon dioxide of the air, and colloidal solutions of copper hydrate are no longer generated. This would check the action of the fungicide on the development of the parasite.

On studying the action of copper in Bordeaux mixture and Bordeaux powder, the writer was able to establish the fact that leaves affected by mildew have an acid reaction. To prove this, leaves that were, respectively, healthy, slightly affected, completely withered, and covered with the characteristic white efflorescence of the fungus were immersed in glasses of distilled water, care being taken to cover the leaf blade only with the liquid. After some days of exposure to the air, it was found that only the water containing healthy leaves gave a neutral reaction, the reaction being more or less acid in the other cases. The acidity was most pronounced in the case of leaves covered with the white efflorescence. From this the conclusion is drawn that the solution of the copper salts is due to very weak acids or acid salts excreted by the parasite during its entry into the tissues. This pathological acidity would easily react on colloidal copper hydrates (but not so easily on copper carbonates formed as indicated above), giving rise to copper ions, to which the fungicidal action may be supposed to be due. When these acid substances do not find copper in the colloidal state on the green portions of the plant, they cause serious functional disturbances and alterations which upset the equilibrium of the physiological activity of the plant and bring about its death or at least the death of the leaves. It is perhaps for this reason that the green parts of plants require to be coated with a reserve of copper in the colloidal hydrate form, even before the spores germinate.

JØRSTAD (I.). **Oversikt over forsøkssprøitninger mot soppsykdommer i frukthaven i året 1921.** [Survey of spraying experiments against fungous diseases of the orchard in the year 1921.]—*Norsk Havetidende*, xxxviii, 4, pp. 75-81, 5, pp. 108-112, 1922.

The experiments, which were carried out in different parts of the country, included tests with lime-sulphur and sulphur dust for the control of apple mildew. The dust contained a small quantity of calcium arsenate. The varieties treated were Gravenstein, White Astrachan, Virginian Rose, and Akerø. The results showed that dusting was only effectual when applied after the opening of the buds, and that it must on no account be substituted for winter spraying. A further disadvantage of dusting is that it requires absolutely calm weather. Apple mildew can be successfully controlled by three sprayings with lime-sulphur, one just before

flowering, one immediately after flowering, and another later, preferably during the latter half of July. Apple rust [*Gymnosporangium juniperinum*] can be held in check simultaneously by these means.

Further experiments with 2 per cent. sodium chloride and lime, 1 per cent. formalin, lime-sulphur and gelatine, lime-sulphur alone, and lime-sulphur with nicotine-soap, showed that the best control of apple mildew was secured by the use of lime-sulphur with nicotine-soap. The sodium chloride solution seriously injured the foliage without arresting the development of the fungus.

Experiments in the control of *Monilia* on Morello and sweet cherries were carried out with lime-sulphur (winter strength), 2 per cent. copper sulphate, and 2 per cent. acid Bordeaux mixture. The results of these experiments were not very conclusive, but showed that a distinct increase in yield resulted from winter spraying.

LEDERLE (P.). **Gefällter Feinschwefel zur Bekämpfung des Mehltaues und anderer verwandter Pilze.** [Precipitated finely divided sulphur for the control of mildew and other allied fungi.]—*Mitt. der staatl. landwirtschaft. Versuchsanst. Augustenberg in Baden, Allg. Weinzeit.*, xxxix, 23, pp. 89–90, 1922.

The many drawbacks incidental to the use of powdered sulphur may be avoided by the following cheap and simple treatment:—Solution 1. 250 gm. hyposulphite of soda dissolved in $\frac{3}{4}$ litre hot tap-water. Solution 2. 250 gm. sodium bisulphate dissolved in $\frac{3}{4}$ litre hot tap-water. Solution 3. 10 gm. of glue dissolved in $\frac{1}{4}$ litre hot water. Solution 3 should be stirred while hot into solution 1. After diluting solutions 1 and 2 each with 4 litres of water, they should be mixed and allowed to stand for 3 to 18 hours, when they are ready for use. By this time the sulphur is precipitated in the form of milk of sulphur. The slightly alkaline mixture may be kept for a few days, but should if possible be used in the morning following the mixing of solutions 1 and 2. It has been successfully applied to vine mildew (*Oidium tuckeri*), rose mildew (*Sphaerotheca pannosa*), gooseberry, apple, and *Euonymus* mildews, and peach leaf curl (*Exoascus deformans*).

KUHL (H.). **De Haens kolloidaler flüssiger Schwefel als Spritzmittel gegen Pflanzenschädlinge.** [De Haen's colloidal liquid sulphur as a spray for plant diseases.]—*Chemiker-Zeit.*, xlv, pp. 479–481, 1921.

At the request of the German Pomological Society the author made an examination of the properties of the colloidal soluble sulphur mixture prepared by the firm of De Haen at Seelze. He found that in consequence of its fine dispersion the adhesiveness of the mixture was very great; milk of sulphur distributed over a slab formed a crust which did not agglomerate either in running or trickling water. Shrubs treated with the mixture withstood a fortnight of incessant rain.

Owing to the intensity of the oxidation promoted by this fine dispersion, leaf-burning was feared, but experiments proved that only in one case (that of the dog-rose) was this of any significance.

Other plants, e.g. vine, gooseberry, cherry, elder, and lilac, were not affected, or only very slightly. At the same time this rapid oxidation of colloidal sulphur should be borne in mind, as very careful handling is necessary. Colloidal sulphur bears the same relation to atmospheric oxygen as pyrophoric iron, which is self-inflammable.

The excellent biological effects of colloidal sulphur and its superiority to other preparations are due both to its great adhesiveness and increased chemical activity. The purely mechanical aspect is explained by the observations of Chrétien (1856), who found that exclusion of air killed the mycelium of the mildew fungus. This was illustrated by the behaviour of certain shrubs in a plantation attacked by mildew, those on the side adjoining the street being practically free from disease. The thick coating of dust which settled on them effectually excluded the air and destroyed the mycelium, without necessitating any kind of treatment. An analogous effect is produced by the dispersion of excessively fine particles of sulphur in the mixture under discussion.

From the chemical standpoint the action of the sulphur is intensified by heat, an increase of which in the case in point is produced by the rapidity of the reaction. The resulting formation of sulphur dioxide contributes to the fungicidal action of the mixture.

De Haen's colloidal sulphur may therefore be regarded as an instance of biological and practical co-operation, its efficacy depending on an increase of chemical activity as well as on its mechanical properties.

SKAIFE (S. H.). **Notes on some South African Entomophthoraceae.** *Trans. Roy. Soc. S. Africa*, ix, 1, pp. 77–86, 3 pl., 1921.

The material on which these notes are based was collected at Cedara, Natal, during 1919–20. The following species were observed: *Empusa muscae* Cohn on muscid flies. *Empusa conglomerata* Sorokin on imago of *Nephrotoma umbripennis* (Alex.). *Empusa grylli* Fresenius was first noticed on 10th January, 1920, on grasshoppers, and was extremely common until the end of March, impartially attacking several different species of Acridiids. *Entomophthora aphidis* Hoffman was first noticed at Cedara on 11th November, 1919, on a large green aphis on peas. It was common on certain species of aphids found on sweet peas, roses, maize, and *Datura stramonium* throughout the summer, serving as a very effective check on these pests. No specimens of the common cabbage aphis or of a black aphis frequent on chrysanthemums were found to be infected. *Entomophthora apiculata* Thaxter on Lepidoptera, imagines of *Lycophotia muscosa* Geyer (Noctuid), of an undetermined Geometrid, and of a Lycaenid, larvae of *Pachypasa capensis*; Diptera, imagines of a large Anthyomid fly and of *Nephrotoma unicingulata* Alex.; Coleoptera, imagines of *Trocalus fulgidus* Fabr. and of *Adoretus ictericus* Burm.; Hemiptera, adults of *Locris arithmetica*. During February and March 1920 this fungus killed large numbers of the beetles named above, the victims being found mostly on the trunks of wattle trees, fixed by means of rhizoids, with their wings partially spread. The fact that various hemipterous insects are liable to attack by Entomophthoraceae

indicates that the host is infected by contact with the conidia, not by their ingestion as maintained by Hesse and others. *Entomophthora megasperma* Cohn on larvae of *Euxoa segetis* Schiff. The author thinks that in all probability Thaxter's *Entomophthora virescens* is identical with *Tarichium megaspermum* Cohn, in which case Cohn's name takes precedence of Thaxter's.

PETCH (C. E.). **Spraying** *versus* **Dusting.**—*Thirteenth Ann. Rept. Quebec Society for the Protection of Plants*, pp. 68-72, 1921.

Dusting has many advantages over spraying, one of the foremost being the rapidity with which it can be carried out. It is also most effective when applied in the early morning or in the evening, i.e. at times which do not interfere with the ordinary work of the farm. Spraying, on the other hand, requires the best of weather and the most important part of the day. The initial expense of purchasing a dusting outfit is about one-half that of a sprayer, and the upkeep is considerably less. Sprayer parts soon become corroded and worn out, but the chemicals in a dry state have little effect upon the duster.

The two outstanding advantages of dusting lie in the fact that fungous diseases develop most rapidly in weather that is suitable for dusting but not for spraying, and in the greater speed, which permits the rapid treatment of large areas. Another important consideration is the injury to foliage and fruit due to burning, which has so far been absent from the experiments with dusting, even with preparations containing as much as 15 per cent. arsenate of lead or 10 per cent. arsenate of calcium. The results of experimental work in New York, Michigan, Illinois, Nova Scotia, and Quebec show that dusting is as efficient as spraying in the control of apple scab and biting insects. Further trials will be necessary before a final decision can be arrived at with regard to the limitations of the two systems.

DICKSON (B. T.). **Studies concerning mosaic diseases.**—*Macdonald College, Canada, Tech. Bull.* 2, 125 pp., 8 pl. 1922.

The plants so far found recorded in the literature as subject to mosaic disease number 96, including mosaic recorded for the first time by the author on *Pisum sativum, Trifolium hybridum, Medicago lupulina*, and probably on *M. sativa*. Of these plants, 30 belong to the Solanaceae, 20 to the Cucurbitaceae, 18 to the Leguminosae, and 7 to the Gramineae, the other 21 plants being distributed through 17 families.

The symptoms shown by plants with mosaic are discussed in detail. Conditions which affect the growth rate of the plants modify the symptoms of the disease; temperature plays an important part, and under certain temperature conditions the symptoms may be masked. Diseased plants may show a great reduction, not only in the amount of seed produced, but also in the germinating power of such seed as is developed.

The histology of the tissues of healthy and affected tobacco, tomato, petunia, potato, black henbane (*Hyoscyamus niger*), pepper, sweet pea, kidney bean (*Phaseolus vulgaris*), broad bean (*Vicia faba*), clovers, Canada field pea (*Pisum sativum*), and

raspberry is described. It was found that in all cases the following histologic modifications occur in affected leaf tissues: (1) Hypoplasia in the lighter green areas, manifest especially in the palisade tissue, but present also in the spongy mesophyll cells, and making such areas about one-third less in thickness than the darker green areas. (2) Reduction in intercellular space volume of these lighter areas. (3) Reduction of chlorophyll content of these cells because of fewer chloroplasts, less chlorophyll per plastid, or breaking down of plastids. (4) The presence in these cells of secondary contents derived from degenerated plastids and, possibly, cytoplasm. (5) Small hyaline bodies, apparently derived from fragmented plastids, are often found in the diseased chlorenchyma. These bodies are in a state of rapid motion, possibly as a result of the presence of invisible, rapidly moving bodies. (6) Reduction in area covered by each epidermal cell over hypoplastic chlorenchyma, but by growth these epidermal cells become either deeper than normal, or develop more trichomes than normal. (7) The transition from hypoplastic to non-hypoplastic tissue is sudden except in slightly affected leaves, and occupies a lineal space of only three or four palisade cells. (8) Under adverse conditions the most hypoplastic tissues may die and thus give rise to brown flecks. (9) The darker green areas are more or less hypertrophied, with more intercellular space, and greater chlorophyll content, than in normal leaves, and such areas are covered with epidermal cells that are larger in area than normal.

Such modifications as result from mosaic in plant parts other than leaves (for example, in the fruits of tomato, pepper, or bean, or sometimes in the stem of tobacco) occur in the chlorenchyma and are similar in nature to the changes in the leaf. Hypoplastic areas may occur in the floral parts of diseased tobacco, petunia, and sweet pea, but in general mosaic affects chlorenchymatous tissues, and the plants become more or less dwarfed in correlation with the duration and severity of infection. In the mosaic diseases studied by the author, no modifications of vascular tissues comparable with those described for leaf roll of potatoes and for sugar-cane and maize mosaic were found.

In considering the aetiology of mosaic, the bacterial, enzymic, virus, and 'amoeba' theories are reviewed. The author has not found amoeboid bodies such as Kunkel described [see this *Review*, i, 6, p. 194], but has found, in free-hand sections of leaves in advanced stages of mosaic, small bodies having an erratic movement and suggesting flagellates, among the hyaline bodies in spongy mesophyll cells and in trichomes. No definite proof that they were flagellates was obtained from non-living sections, nor could protozoan organisms be isolated. A bacterial flora is almost invariably present in diseased leaves. In sections of tobacco killed in a concentrated alcoholic solution of mercuric chloride and stained by the Giemsa method, minute dark-staining bodies, $0{\cdot}3\,\mu$ long and slightly less in width, were found, sometimes in great numbers, in the border parenchyma of the vascular tissues of diseased leaves; these bodies were not found in healthy leaves. They were also observed in close contact with the walls of the chlorenchyma cells, and in some cases surrounded the chloroplasts.

These are apparently the same bodies observed by Ivanovski and others, and while they may be secondary, it is possible that they may be akin to the Chlamydozoa described in virus diseases of animals and man. Attempts to isolate and culture these bodies on gelatine or agar failed, but in bouillon there developed from bits of hypoplastic tissue of tobacco, after surface sterilization, minute organisms, sometimes in zoogloeae and sometimes in *Streptococcus*-like chains. Inoculations with 0·5 c.c. of this bouillon were made, and in twelve of fifteen plants typical mosaic developed after eighteen to twenty-one days. The author recognizes, however, that some 'virus' as well as the *Streptococcus*-like organism may have been present. Similar bouillon cultures were made from 0·1 c.c. of plant juice diluted 100 times and passed through a Chamberland F filter; slight turbidity was apparent after four days at room temperature, and infection occurred in all plants inoculated.

The experiments of Lodewijks concerning the relation of coloured light to mosaic were repeated under more exact conditions. Lights of different wave-length were found to exert some influence, by enhancing (green light) or masking (blue light) the symptoms, but the effects are probably caused by alterations in the growth rate, etc., of the plants, rather than by an effect upon the causative agent of the disease. Extracted sap from diseased tobacco plants remained virulent after exposure to lights of different colour. Extended freezing, however, reduced the virulence of the filtered juice from diseased plants.

The aphid *Macrosiphum pisi* Kalt. was shown to transmit mosaic between *Trifolium pratense*, *T. hybridum*, *T. repens*, *T. incarnatum*, and *Medicago lupulina*, and cross-inoculations with expressed juice from diseased plants were also successful between these hosts. In one case, mosaic was transferred by the above aphid from *Trifolium pratense* to *Medicago sativa*. Raspberry mosaic is also transmitted by aphids, probably *Aphis rubiphila*. Cross-inoculations between the clovers and *Pisum sativum* or *Phaseolus vulgaris* were unsuccessful, except in the case of one plant of *T. hybridum* which was infected from *P. sativum*.

Seed inheritance of mosaic was found to occur in *Pisum sativum*, *Trifolium pratense*, *T. hybridum*, *Melilotus alba*, and probably in *Hippeastrum*, but was not found to occur in raspberry.

A discussion of mosaic of raspberry is included, the disease being differentiated from 'yellows' or 'curl'. Streak and leaf drop of potatoes are noted as regards the possible relation of these diseases to potato mosaic.

The literature (153 titles) is summarized under the various topics discussed. The plates were made from contact photographs of mosaic leaves and from drawings to show the histological details of diseased and normal tissue.

PALM (B. T.). **De Mozaiekziekte van de Tabak een Chlamydozoonose? (Voorloopige mededeeling.)** [Is the mosaic disease of Tobacco a Chlamydozoonose? (Preliminary note.)]—*Bull. Deliproefstat. te Medan-Sumatra*, 15, pp. 1–16, 1922. [With English translation.]

The results of previous work by other investigators in connexion

with the cause of mosaic are briefly referred to. While it has been classed amongst 'degeneration diseases' by some, and ascribed to enzymic action by others, a third group has adhered to the view that the disease is due to an ultramicroscopic organism, or at least to one not rendered visible by the usual staining agents. Since 1903, when Ivanovski found a very small bacterium, which could be filtered from tissues of tobacco affected with mosaic, no work undertaken in accordance with modern cytological methods is known to the author; the present paper gives the result of some investigations carried out by such methods. The material studied was taken from diseased plants of the Deli variety, grown at Medan; the fixing fluids employed were Flemming's mixture in various concentrations, hot alcoholic sublimate, and Zenker's fluid; while Heidenhain's haematoxylin, eosin, and Loeffler's methylene blue were used for staining.

In many of the cells of the mosaic tissue, fairly large, peculiarly shaped, frequently amoebiform, less frequently round to spherical corpuscles were found either in intimate contact with the nucleus or in its immediate vicinity. Sometimes more than one such body is present in a cell. Other very small granules of varying size may also occur, either alone or in association with the larger bodies described. The larger corpuscles are generally reticulate, but sometimes appear to be almost without definite structure; one or more spaces resembling vacuoles are now and then visible. In well-stained sections it is generally possible to see a small number of granules in the corpuscles. A membrane does not appear to be formed. Seeing that these cell inclusions are entirely absent from the cells of the healthy tissues, it is natural to connect them with the disease.

The larger corpuscles stain grey with haematoxylin, and are light red with eosin; they are also very clearly seen in unstained preparations of living material (especially in the hairs on the diseased portions of the leaves), and have much the same appearance as in the fixed preparations. They are denser and more opaque than the surrounding cell plasma. They do not seem to possess automotive power, though the normal movement of the plasma may displace them at times.

The smaller granules, which have a maximum size of $0{\cdot}5\ \mu$, occur chiefly during the later stages of the disease. They stain blackish with haematoxylin after fixation in Zenker's fluid, and light blue with Loeffler's methylene blue. They frequently lie in irregularly-shaped groups in the cell plasma, sometimes completely filling the lumen. While sometimes rounded in shape, they are generally of greater length than breadth, and some, evidently in a process of division, are drawn out in the centre. Larger granules—up to about $1{\cdot}5\ \mu$—were seen in other cells, but the author was unable to determine whether these were normal cell constituents, or products of reaction of diseased cells, or stages in the development of the smaller bodies. The nucleus in diseased cells is often hypertrophied, and may show symptoms of degeneration.

The author's observations agree on the whole with those of Ivanovski. The latter believed that the diminutive granules found in the cells of tobacco plants affected with mosaic were

bacteria, and that the larger corpuscles were products of the reaction of the cell plasma to infection. Palm, however, points out that the small bodies agree in every respect with the so-called Chlamydozoon-Strongyloplasma or 'elementary corpuscles' of von Prowazek and Lipschütz, found in certain of the filterable virus diseases of animals and man. The larger amoebiform bodies are considered as homologous with the so-called corpuscles of Guarnieri associated with variola. It is, therefore, suggested that mosaic disease of tobacco belongs aetiologically to the Chlamydozoonoses, and the author proposes the name *Strongyloplasma ivanovskii* n. sp. for the presumed organism described above.

McDOUGALL (W. B.). **Mycorrhizas of Coniferous trees.**—*Journ. of Forestry*, xx, 3, pp. 255-260, 3 figs., 1922.

The present paper is based on materials collected by Dr. Barrington Moore at Bar Harbour, Mount Desert Island, Maine, in October 1921. The collections included mycorrhiza from *Picea rubra*, *Abies balsamea*, and *Pinus strobus*, together with fruit bodies of the mycorrhizal fungi of the first two.

The fruit bodies in both cases were species of *Cortinarius* which are described but not named. According to the collector, that from *Picea rubra* also forms mycorrhiza on balsam fir, yellow birch, and possibly other trees. Several species of *Cortinarius* have already been reported as forming mycorrhiza, e. g. *C. callisteus* on pine, *C. caerulescens* on beech, and *C. fulmineus* on oak (Noack), *C. rubipes* on *Quercus rubra*, *Acer saccharum*, and *Celastrus scandens* (Kauffman), and *Cortinarius* sp. on *Betula alba* var. *papyrifera* (McDougall). The present report, however, is believed to be the first authentic determination of a mycorrhizal fungus on *Picea*.

The mycorrhiza of this tree are bright yellow owing to the colour of the mycelium. They are very small and do not form coral clusters as a rule. The fungus mantle appears to be rather loose; the fungus layer thin and not very compact. Microscopic examination showed that the fungus had penetrated between the first, and often also the second, row of cortical root cells, but the latter were not elongated.

The fungus of *Abies balsamea* is believed by the collector to form mycorrhiza also on spruce and white pine. The *Abies* mycorrhiza are very similar to those of *Picea rubra* except in colour, which is white. The relatively thin and loosely constructed mantle appears to be somewhat characteristic of mycorrhiza caused by species of *Cortinarius*.

The material from *Pinus strobus* consisted of two seedlings with several peculiar nodules on their roots, resembling the tubercles on the roots of leguminous plants. The nodules were pale yellowish or buff colour, 1 to 4 mm. in diameter. They are apparently very uncommon, since the collector examined numbers of *P. strobus* roots from which they were absent.

The author believes that no such structures have been described in previous literature. 'Coral' clusters of mycorrhiza, containing large numbers of rootlets, are familiar on the roots of spruce, oak, and hickory. In the present instance, however, the rootlets are bound together by the mycelium into a compact tubercle. The

character of the fungous tissue is similar to that of many other ectotrophic mycorrhiza. The formation of the tubercles, therefore, may have been due to an unusually luxuriant growth of the mycelium, possibly characteristic of the species of fungus concerned, or due to exceptionally favourable vegetative conditions. No sporophores were found, so the identity of the fungus symbiont remains uncertain.

The author considers that there is no evidence to support the old theory that the ectotrophic mycorrhizal fungi assist the host plants in the absorption of nutriment from the soil, and states that the consensus of opinion among recent workers is that the higher plants receive no benefit whatever from the association, which represents an instance of 'antagonistic nutritive conjunctive symbiosis'. Though in ordinary cases the host plant is not seriously injured by the association, any unusual abundance of the mycorrhiza may interfere to a considerable degree with the functions of the root system. It is now believed that the mycorrhizal fungi produce their fruit bodies soon after they have fully established relations with the host plant. It seems probable, therefore, that the mycorrhiza is, in a sense, a substitute for the sclerotium. Possibly the tubercles described in this paper are due to a greater tendency to sclerotium formation in the fungus concerned than is usual with mycorrhizal fungi.

SMITH (C. O.). **Some studies relating to infection and resistance to Walnut blight.**—*Monthly Bull. Dept. Agric. California*, x, 9, pp. 367–371, 1 fig., 1921.

Walnut blight is caused by the yellow chromogenic organism *Pseudomonas juglandis* Pierce, which attacks the leaves, nuts, catkins, and tender shoots of *Juglans regia*. The only known sources of infection are the old blight lesions, where the organism hibernates and under favourable conditions appears on the surface in a bacterial exudate. It may then be transported by different agencies to the foliage, where it causes new infections. It was recently demonstrated that the walnut blight organism may occur on the surface of both the leaf and catkin buds before the beginning of their spring growth. The old lesions on the trees were the only sources from which the organism could have come in these cases.

Inoculation experiments showed that dormant buds do not often become infected until visible new growth has appeared. Fog, dew, and late rains are important factors in the spread of the disease, which is probably also disseminated to some extent by insects and pollen. The diseased catkin shows a mass of blackened, watery, flower clusters, usually not expanded, while the rachis is also often blackened, and may be bent or twisted. The organism has been isolated from diseased catkins and pollen from such catkins in spring.

Careful experiments have been undertaken to ascertain whether or not the soil may be a source of blight infection. Tests were made in sterilized and unsterilized soil, and the observations are in close agreement with those of Lee and Fulton in their study of the relationship of soil to the citrus-canker organism (*Journ. Agric. Res.*, xix, 5, pp. 189–204 and 207–234, 1920). Both in sterilized

and unsterilized soils the number of colonies in the dilution-plates begins to decrease after twenty-four hours' incubation of the soil at 20° C., and at the end of six to nine days the organism was not isolated from unsterilized inoculated soil, while in the sterilized soils it was isolated after eighteen but not after twenty-five days. These preliminary results indicate that the soil is not a medium of infection.

Tests of several commercial varieties of walnuts, as well as orchard observations, show that Ehrhardt is less susceptible than Placentia and Seedlings.

ARMSTRONG (G. M.). **Studies in the physiology of the fungi. XIV. Sulphur nutrition: the use of thiosulphate as influenced by hydrogen-ion concentration.**—*Ann. Mo. Bot. Gard.*, viii, 3, pp. 237–281, 21 figs., 1922.

The author used *Aspergillus niger*, *Penicillium glaucum*, *P. cyclopium*, and *Botrytis cinerea* in cultures at various hydrogen-ion concentrations in order to determine certain phases of sulphur metabolism of these fungi.

The following compounds proved, in general, favourable sources of sulphur, in the order named: $MgSO_4$, $Na_2S_2O_3$, $MnSO_4$, KSH, $KHSO_3$, $K_2S_2O_8$, KCNS, NH_4CNS, K_2S. The fungi produced H_2S except when $MnSO_4$, $MgSO_4$, or $K_2S_2O_8$ was used, and regardless of the hydrogen-ion concentration, concentration of the salt, or relative degree of growth. When $Na_2S_2O_3$ was used, sulphates were the chief end products of its decomposition, although H_2S and tetrathionate also may occur, and sometimes molecular sulphur, or globules of sulphur in the hyphae, were found.

The reaction of the medium may change during the growth of the fungi. With *Aspergillus niger* the acidity increases (and may reach P_H 1·5), but when the sugar in the medium is used up the reaction reverses. *Penicillium cyclopium* may cause a reversion of the reaction with sugar present in the solution. The course of the changes occurring in the medium cannot be determined merely from a determination of the initial and final hydrogen-ion concentrations.

WEBB (R. W.). **Studies in the physiology of the fungi. XV. Germination of the spores of certain fungi in relation to hydrogen-ion concentration.**—*Ann. Mo. Bot. Gard.*, viii, 3, pp. 283–341, 39 figs., 1922.

The author tested the germination of the spores of *Aspergillus niger*, *Botrytis cinerea*, *Colletotrichum gossypii*, *Fusarium* sp. (from a cotton boll), *Lenzites saepiaria*, *Penicillium cyclopium*, *P. italicum*, and *Puccinia graminis* in various nutrient solutions at different hydrogen- and hydroxyl-ion concentrations.

C. gossypii spores germinated best in an alkaline medium, and *Fusarium* sp. showed as great or greater germination on the alkaline side as on the acid side, but the other fungi tested gave the best spore germination under conditions of active acidity, usually exhibiting a maximum at P_H 3·0 to 4·0, sometimes with a secondary maximum in the vicinity of P_H 7·0. Spore germination with all the fungi occurred over a wide range of hydrogen-ion concentration;

with most of the fungi the percentage of germination did not fall off greatly on the acid side until P_H 2·5 to 1·5 was reached, when the decrease in germination was abrupt. There was a more gradual and diverse relation on the alkaline side, but most of the fungi showed germination up to P_H 9·0, and in several cases germination occurred at P_H 10·0. *C. gossypii* germinated but poorly at greater acidity than P_H 3·0 to 4·0, while *L. saepiaria* showed little germination on the alkaline side, i. e. little or no germination usually occurred in greater alkalinity than P_H 7·0 to 8·0. The medium in which the spores are placed sometimes markedly affects their germination in relation to hydrogen-ion concentration; sugar-beet decoction, for example, seems to possess some substance or set of conditions which stimulates germination. The method of germination was also affected by the medium: *C. gossypii* germinated by the production of secondary spores instead of germ-tubes in peptone solution; this does not appear to depend upon the hydrogen-ion concentration.

A change in the reaction of the medium may or may not occur during germination. A medium in which some spore germination will occur is not necessarily a good medium for mycelial growth; thus the germ-tubes of *B. cinerea* disintegrated at P_H 2·1. The germ-tubes in other cases were often irregular or abnormal in strongly acid or alkaline solutions.

Neither an extension of the time during which germination was allowed to proceed nor a temperature range of 4 to 5° C. above or below a provisional optimum affected the curve of percentage of spore germination in the various solutions.

A few tests were made with spores of *Ustilago avenae*. In mannite solutions germination occurred at concentrations from P_H 2·4 to 8·2 with a maximum at P_H 6·2. Sporidia were formed most abundantly from P_H 5·4 to 7·0.

Conidia of *Sphaerotheca pannosa* failed to germinate in any of the solutions tested, whether the trials were made with fresh conidia or with conidia subjected first to low or freezing temperatures.

De Bruyn (Helena L. G.). **The saprophytic life of Phytophthora in the soil.**—*Meded. van de Landbouwhoogeschool, Wageningen*, xxiv, Paper 4, pp. 1–38, 2 pl., 1922. [English, with Dutch summary.]

From a survey of the literature the author concludes that most species of *Phytophthora* can develop as saprophytes in the soil. Amongst the species of which the life-history is more or less fully known, *P. fagi, cactorum, nicotianae, syringae, parasitica, terrestria, cryptogea, erythroseptica*, and *arecae* have been proved by other workers to be present in some form in soil, while this has not been established in the case of *phaseoli, colocasiae, infestans, faberi*, and *meadii*. Reasons are given for the statement that previous work does not exclude the possibility that the latter (except *meadii*) may be present in the soil, or at least that their life-histories may at times include a soil stage.

The author worked with *Phytophthora syringae, erythroseptica*, and *infestans*, which were grown in culture on different types of

sterilized soil in test-tubes. *P. syringae* infected lilac after having lived as long as two years on bog-soil. Conidia and a few oospores were formed in the various types of soil inoculated. *P. erythroseptica* formed many oospores and considerable aerial mycelium in soil culture, but produced conidia only when drops of water were present. Pink rot of potato tubers was produced upon inoculating from cultures which had grown continuously on soil for one and a half years. With both these species the fungus was still viable in soil in test-tubes after having grown without transfer for one year. On the soils tested *P. infestans* grew best on clay and bog soil, less well on leaf-mould, and rather poorly on sand. This experience may be correlated with the fact that potato blight is more severe in clay than in sandy soil. Considerable aerial mycelium and many conidia may be produced during the saprophytic growth of this fungus in soil. If a culture on raw potato be covered with sterilized soil, the mycelium can grow through the soil and reach the surface. Water which had been poured over fruiting cultures of *P. infestans,* and consequently contained conidia and some hyphae, was poured over sterilized soil: conidiophores were subsequently found arising from the soil, and sometimes a luxuriant mycelial growth appeared. Thus the common conception that potato tubers are infected in the soil by conidia that have percolated down to them with a current of water need not be maintained; the fungus can reach the tubers by growing through the soil. The fungus was still able to infect living pieces of potato tuber after having lived on clay alone for eleven months.

P. syringae and *P. erythroseptica* overwintered on soil and other media in tubes left out of doors during the winter both in 1920–21 and 1921–22, the former species in mycelial condition, the latter apparently only as oospores. During these winters the cultures were subjected to temperatures occasionally as low as $-12°$ C., and sometimes for considerable periods below $0°$ C. *P. infestans* withstood an exposure of nine days during which the temperature reached $-9°$ C., and an exposure out of doors from 15th January, 1921, until the following spring, during which the temperature fell below $0°$ C. on eight nights; but cultures on various media placed outside in October 1921 could not be revived in December or thereafter, having perhaps been killed by severe frosts from 27th November to 6th December. It is therefore uncertain whether this fungus can overwinter in the soil, especially in regions where frosts are common or severe.

P. syringae and *P. erythroseptica* were found to develop also in unsterilized soil, and to produce infection after having grown in such soil out of doors for about five months during the winter.

It will be apparent from the results of these experiments that at least three species of *Phytophthora*, and probably more, can live as saprophytes in the soil for considerable periods. The fact that no oospores of certain species have been found in nature does not preclude the possibility of the saprophytic existence of such species. The occurrence of a saprophytic stage in certain species of *Phytophthora* renders it impossible to control these diseases by means of crop rotation. There are references in phytopathological literature to the continued existence in the soil of *Phytophthora fagi* after

four years, *P. nicotianae* after three years, and *P. cactorum* after two years. Control measures must be directed to defending the plants against the attacks of the fungus, such as spraying with fungicides or cultivating resistant varieties. [See also this *Review*, i, 8, p. 253.]

NOWOTNY (R.) **Ueber praktische Erfahrungen mit Holzimprägniermitteln.** [Practical experiments with wood preservatives.] —*Zeitschr. angew. Chemie*, xxxv, 37, pp. 217–219, 1922.

Observations and experiments extending over a number of years have shown that the treatment with a strong preservative of all poles and other structural timber used in mines is necessary to combat the attacks of the various wood-destroying fungi. Untreated pine wood used in the mines near Dortmund lasted on an average only a year and a quarter, the severity of the fungous attacks being far greater in the mines than in the open. It was ascertained by means of a number of experiments that only very strong preservatives were effective in controlling the decay. The best results were obtained by the use of 'Basilite' (88·89 per cent. sodium fluoride and 11·11 per cent. of dinitrophenol aniline), the wood treated with 3 kg. of Basilite per cb. m. remaining immune during the seven years over which the experiments extended. Weak antiseptics such as sodium silicate with or without lime proved totally ineffectual. Good results were also obtained by the use of 'Glückauf' (nitrated phenol), 'Viczsal' (ammoniacal solution of metallic salts (Cu, Zn), phenol, and cresol), and the Rüping tar oil process, applied respectively in the proportions of 12·5 kg., 15·3 kg., and 58·3 kg. per cb. m.

WOLF (F. A.). **A leaf spot disease of Tobacco caused by Phyllosticta nicotiana E. & E.**—*Phytopath.*, xii, 2, pp. 99–101, 1922.

This fungus causes a minor spotting of the foliage of tobacco seedlings or more mature plants. The conidia were found to be 6 to 10 by 3 to 3·5 μ. The fungus does not altogether agree with Ellis and Everhart's brief description, and the type specimens of *P. nicotiana* are missing, but it is considered advisable to accept the above identification.

GARDNER (M. W.) & KENDRICK (J. B.). **Tomato mosaic.**—*Purdue Univ. Agric. Exper. Stat. Bull.* 261, 24 pp., 13 figs., 1922.

This is a semi-popular account. No variety of tomato has been found resistant among sixty-three seedsman's varieties, and the mosaic has been transferred to currant tomato (*Lycopersicum pimpinnellifolium*), cherry tomato (*L. esculentum* var. *cerasiforme*), and Chinese scarlet eggplant (*Solanum integrifolium*).

The symptoms of mosaic on tomato plants are variable and, besides the mottling, there may be stunting, malformation, crumpling, curling, crinkling, or spotting of the leaflets; blighting of shoots; brown, dead spots and streaks on the petioles and stems; and elevated greasy areas or streaks, becoming dryish, brown, and sunken, on the fruits. The 'winter-blight' and certain other 'blights' of the older literature probably referred to mosaic.

Mosaic may be spread by insects and evidently by handling the

plants during cultural operations. There is no evidence that the disease persists in the soil. Mosaic is especially severe when the plants become infected early, i. e. in the seed beds. The relation of weeds to the disease is discussed.

ANDERSON (M. L.). **Soil conditions affecting the prevalence of Fomes annosus [Trametes radiciperda].**—*Trans. Roy. Scot. Arbor. Soc.*, xxxv, pp. 112–117, 1921.

Fomes annosus, one of the most serious fungous diseases of conifers in Scotland, occurs most commonly in the drier parts of the country, i. e. the north and north-east. It attacks the roots, causing heart rot and root rot. It rarely produces fructifications on sandy open soil, but on stiff clay the sporophores are usually conspicuous. It must not be supposed, however, that the fungus is more common on stiff soils, as it occurs at least equally often on light sand. The texture of the soil appears to influence greatly the mode of attack. Thus in open, porous soils a slight extension of the fungus may bring the hyphae into contact with a weakened rootlet, which is quite sufficient to cause infection. The hyphae are apparently able to extend for short distances through open soil, but in impermeable soils the fungus may be tied down to one tree, and in such cases sporophores are more readily produced. The fungus may easily be overlooked in the former case, owing to the absence of sporophores, while all the time doing considerable damage underground.

Fomes annosus seldom or never attacks living and healthy hardwoods [broad-leaved trees], even when the latter are grown with badly-damaged conifers under similar conditions. This seems to indicate some special protective tissue in the roots of hardwoods, which is able to counteract a destructive agency in the soil acting adversely upon conifers.

The writer believes this injurious soil factor to be acidity, which weakens the roots of the conifers and exposes them to attack by the ferments or enzymes of the fungus. Most Scottish forest soils tend to acidity, but some species of conifers seem to be less liable than others to the resultant effects. This excess of acidity may be due either to the nature of the soil or to the over-accumulation of humus.

The view that soil acidity is the dominant predisposing cause of attack is supported by a number of facts.

Fomes annosus is very common in all parts where one crop of conifers is succeeded by another, especially in impermeable soil; this may be due to acidity caused by the non-decomposition of the humus of the first crop. It is also frequent in first plantations on old agricultural soil, where the subsoil drainage conditions are usually very bad, producing acidity in the upper layer.

The natural distribution of the trees is of interest in this connexion. Hardwoods replace conifers naturally on the boulder tills [glacial clays] all over the country, which, owing to poor drainage, are usually of an acid nature. Spruce and larch are normally restricted to well-drained soils formed from the decay of rock

in situ, where the easily soluble bases are most concentrated. Douglas fir in America and Scots pine in Scotland occur normally on glacial sands and gravels where both species utilize mycorrhiza to a great extent. Possibly this symbiosis enables the trees to withstand the acids. Both these species are liable to severe attack on the more fertile clays and clay-loams. In these badly-aerated soils mycorrhiza do not thrive, and the trees are thus more or less dependent on their own root-hairs.

Groups of trees surrounding old stumps of a former crop are frequently attacked on more or less impermeable soils. This appears to be due not only to direct infection from the old stumps, but also to a local acidity produced in the soil by their decay. The removal of the acids is prevented by the nature of the soil. *Fomes annosus* is apt to occur on all types of soil where there is an excess of dead vegetable matter. This applies also to soils from acid igneous rocks, such as granite, where the bases have been leached out, as in the glacial sand and gravels of north-east Scotland. There the Scots pine seems less liable to attack than larch or spruce, especially on poorer soils where assistance from mycorrhiza may be expected.

Heart rot appears in young and middle-aged woods some time after the canopy has been closed. No doubt the practice of close planting, combined with neglect of thinning, has resulted in an excess of raw humus. The latter, by the formation of acidity in the soil, damages the rootlets and renders them liable to attack.

Conifers, especially Douglas firs, attacked by heart rot are very apt to succumb to wind and snow-storms. In nearly every instance careful inspection of the roots of fallen trees will reveal the presence of *F. annosus*. Attempts at eradication in a growing wood are hopeless, and the difficulty must be solved by the proper selection of species adapted to the several types of soil. Assuming soil acidity to be the primary cause of attack, the following rules, with the necessary modifications for economic reasons, should be applied to sylvicultural practice:

1. Stumps and other dead material should be removed from prospective sites for planting.
2. Bracken, heather, blaeberry, etc., should be burnt before planting. These plants tend to form an accumulation of raw humus, especially in dry sandy soils.
3. The degree of soil acidity should be ascertained. Conifers can safely be planted in basic, neutral, or slightly acid soils. All or most of these soils are residual or approaching that type, and are well suited for larch, Japanese larch, spruce, Douglas fir, etc.
4. A high degree of acidity in the soil may be due to excess of raw humus, and a number of years should elapse to allow of its decomposition. This condition is frequently the result of clear felling a wood which has been grown as dense as possible.
5. In soils with a high degree of natural acidity, such as usually exists over boulder tills, either pure hardwood or a large percentage of it is probably best. Scots pine, however, grows very well on some boulder tills, as also do certain firs, notably *Abies grandis*. It is a mistake to neglect the cultivation of hardwoods, which are

not only resistant to the root fungus but also tend to counteract soil acidity.

6. Scots pine is probably the tree best suited to very impoverished or unfertile soils such as peat, while the possibilities of birch should not be overlooked.

The virulence of *F. annosus* would certainly be reduced by attention to the above rules. Damage in a growing wood may be mitigated by drastic thinning, which enables the accumulated humic acid of the upper soil layers to be removed by oxidation. If no improvement follows, the wood should be clear felled and planted with suitable trees.

The fungus appears to live only in the upper soil layers, into which the spores may be carried by rabbits and other animals, or washed by rain-water from the bases of the standing trees. It is in these upper soil layers that the greatest concentration of acid takes place, with the consequent damage to the rootlets.

HILEY (W. E.). **The Larch needle-cast fungus, Meria laricis Vuill.** —*Quart. Journ. of Forestry*, xv, 1, pp. 57–62, 2 figs., 1921.

The brown discoloration and shedding of young larch needles during the summer, commonly attributed to frost, was found to be due to *Meria laricis* Vuill. Numerous large hyphae up to 10 μ broad, and with thick gelatinous walls, are visible under the microscope in sections of the brown needles. These coarse hyphae give off finer ones, some of which penetrate the mesophyll cells of the leaf.

Fructifications are formed only in a humid atmosphere. Specimens of *Larix europaea* and *L. occidentalis* received from Argyllshire showed characteristic conidiophores growing out in bundles, 60 to 100 μ in diameter, through the stomata. These bundles only appear on the brown portion of the needle, and usually emerge on the lower surface near the midrib, but occasionally also on the upper surface. The individual hyphae composing the bundle are colourless and septate. From the apex of each segment a conidium, $8\text{–}10 \times 2{\cdot}6\text{–}2{\cdot}7\ \mu$, may be abstricted, secondary conidia also being produced. These conidia, which are liberated in a damp atmosphere, infect other larch needles in a manner not yet exactly determined.

The attack observed by the writer became noticeable on six to seven year old trees in June 1920. The needles on the long shoots began to turn yellowish-brown at or near their apices. The discoloration then spread towards the bases and became darker in tone, the maximum severity of attack occurring two or three inches from the apices. The mycelium did not penetrate to the stem, so the young needles must have been infected individually. In September only small tufts of green needles were left at the tops of the shoots. Infection probably took place in older trees through wounds caused by the larch needle moth (*Coleophora laricella*). There is little doubt that the fungus hibernates in the needles, reinfecting trees from the ground in the spring.

The disease may be distinguished from frost injury by the facts that the youngest needles are not affected, and that each needle does not die throughout its whole length at once. It is most destructive in nursery lines and young plantations, the heavy loss of needles

during the growing season reducing the increment both of height and volume. Hartig showed that *Sphaerella laricina* was most destructive in larch woods mixed with spruce, the diseased larch needles catching in the spruce twigs and remaining there till the spring, when the ascospores reinfected the larch. Underplanting with beech as a substitute for spruce gave excellent results, and this method might also prove successful in the case of *Meria laricis*.

The larch needle-cast appears to be very widespread in Britain. The western American larch is also attacked, but the Japanese variety seems to be immune.

A brief account of the history of the disease is given, and a bibliography appended.

TAUBENHAUS (J. J.) & MALLY (F. W.). **Pink root disease of Onions and its control in Texas.**—*Texas Agric. Exper. Stat. Bull.* 273, 42 pp., 3 figs., 1921.

Since 1906 considerable damage has been caused to this important crop in Texas by a disease popularly known as pink root. Losses up to 43 per cent. have been observed, representing nearly $350 per acre. To this must be added the increased susceptibility of affected onions, in transit or in storage, to black mould decay (*Aspergillus niger*) and soft rot (*Bacillus carotovorus*), though pink root in itself does not cause any decay of the bulb.

The disease is widely distributed, having been noted in California, Wisconsin, Iowa, New York, and in the Bermuda Islands (whence, according to the authors, it undoubtedly emanated). Of Liliaceous plants tested, only species of *Allium* (the onion, shallot, and garlic) are subject to pink root disease, Narcissus, Tulip, Funkia, Iris, Freesia, Lily and Calla being immune. Amongst onion varieties, the true Bermuda Crystal White Wax, White (Yellow) Bermuda, Red Bermuda, and Extra Early Red are more or less resistant, while Denia (and other Spanish strains), Yellow Dutch, Strasburg, Yellow Denvers, Australian Brown; Large Red Globe, Large Red Wethersfield, Large White Globe, White Portugal (Philadelphia), and White Silverskin are highly susceptible. In the latter category must also be placed practically all the 'multiplier' varieties of onions, in addition to shallots. Amongst garlic varieties, several strains of the Mexican and Italian, especially the pink type, are more subject to the disease than the large white varieties known as the Chinese.

Pink root has been proved by the authors to be caused by a *Fusarium* which is tentatively named *F. malli* Taub. n. sp. It resembles *F. oxysporum*, differing chiefly in forming pionnotes instead of pseudopionnotes. *F. malli* is generally found associated with another species of *Fusarium*, which is apparently non-parasitic by itself, but seems to increase the virulence of *F. malli*. The above-ground symptoms of the disease are not always easily recognizable, except in the case of severe infections, when the plants have a stunted appearance. The trouble is confined to the growing roots, bulb plate, and crown, and does not affect the onion or garlic bulb, except to reduce its size owing to the expenditure of most of the available energy in replacing diseased roots. The latter are dry,

dead, and yellow, later frequently turning pink. Plants are subject to attack during all stages of their development, from the seed-bed onwards, but the inhibitory effect on growth is more marked when the bulbs begin to form and when they approach maturity. In severe cases new roots become pink as fast as they are formed, and a projecting nipple is formed at the bottom plate of the bulb marking the site of this repeated production of new roots.

The popular belief that the disease is due to alkali in the soil has been proved erroneous by the authors' tests, but, in excess, alkaline substances in the soil may become contributory causes by lowering the resistance of the plants. Adverse climatic conditions and careless cultural methods have the same effect. Even distribution of moisture through proper levelling of the ground, frequent waterings, and abundant humus in the soil, encourage vigorous growth and thus reduce the loss. The disease is favoured by any check in the growth of the plants, either through frost or through delay in ripening until the very hot weather sets in. Thrips and eelworms also encourage infection by weakening the plants.

The seed is, however, often sown in infected seed-beds and the green setts taken from these for planting out will carry the disease. Attempts to reduce soil infection by treating the soil with lime or sulphur failed. Formaldehyde and steam were used in attempts to disinfect the seed-bed soil, with considerable success. Treatment with a solution of one pint of formaldehyde in twenty gallons of water applied at the rate of one gallon per square foot reduced the attack from over 80 to 0·6 per cent. in field tests. Steaming at 15 lb. pressure for two hours killed the fungus. Setts grown in infected seed-beds were dipped in formaldehyde or copper sulphate before planting out, but effective strengths were found to be dangerous to the setts.

A three or four years' rotation is advisable in infected fields. Where, however, onions have to be grown more often on such land, heavy artificial manuring should be resorted to, as this may give the plants enough vigour to outgrow the disease; the authors recommend the use of 1,000 lb. per acre of a compound analysing about 7 per cent. acid phosphate, 5 per cent. nitrate of soda, and 2 per cent. potash.

EDGERTON (C. W.). **Onion diseases and Onion seed production.**— *Louisiana Agric. Exper. Stat. Bull.* 182, 20 pp., 9 figs., 1921.

Onion diseases, especially black stalk rot (*Macrosporium parasiticum*), have been very prevalent for some years in the Bayou Lafourche region, the most important onion-growing district of Louisiana. Almost every year the seed crop has been reduced at a moderate estimate by at least 50 per cent., chiefly from *M. parasiticum,* while considerable damage is done to the bulb crop by various diseases. The seed almost exclusively used is a local variety known as the Creole onion. During the war investigations were undertaken to test the possibility of control by means of spraying. The work, which was restricted to observations on the diseases and some preliminary experiments, has now been discontinued, as there is no longer any shortage of seed.

The stems of the diseased seed onions become covered with a black, smutty layer composed of the spores and mycelium of *M. parasiticum*. Many stems either rot away or become so weakened that they are blown over, or collapse under their own weight. Very few of the broken or bent stalks produce much seed, while the yield of the standing stalks is also greatly reduced.

Climatic and soil conditions appear to influence considerably the development of this and other onion diseases. Thus at Bayou Lafourche the rainfall is heavy and humidity high, thick fogs being common during the early spring. The soil is heavy, and not well drained. Baton Rouge, where part of the investigations were carried on, is further from the Gulf, and situated on higher ground. The fogs are less frequent, humidity is somewhat lower, and the general incidence of disease is much less.

Besides *M. parasiticum*, the following fungi are frequently present on onion plants: *Peronospora schleideni*, *Colletotrichum circinans*, a species of *Botrytis*, *Fusarium malli*. and another species of *Fusarium*. The first named is, however, almost the only disease recognized by the growers, and it alone is found on old plants. A heavy development of the black stalk rot frequently succeeds a severe outbreak of onion mildew (*Peronospora schleideni*). The latter has never been seen on the high land at Baton Rouge, even on plants grown from bulbs from the infested regions. *Colletotrichum circinans* is often found on the plants and bulbs, causing onion smudge on the latter. Neither this nor the species of *Botrytis* responsible for neck rot in other regions is of any great economic importance. Pink root disease (*Fusarium malli*) occurs in various parts of Louisiana, where it has been known since 1909 both on the bulbs and seed crops. Another species of *Fusarium* produces a rot of the roots which sometimes affects the base of the stalk. Arrested growth and partial sterility follow.

Evidently *M. parasiticum* is more definitely parasitic than is commonly believed, and will develop rapidly on any slightly weakened tissue. It may even attack the uninjured plant, and spread rapidly after once gaining entrance to the stalk, especially under conditions of great humidity.

A white spot disease of undetermined origin also predisposes to severe attack by *M. parasiticum*. It first appears in the form of chlorotic spots on the stem, usually on the enlarged portion just above the ground. These perfectly white spots are more or less circular and gradually increase in size. Cultures from them have always given negative results, and the spots may be of physiological origin.

Spraying experiments were carried out at Baton Rouge and Bayou Lafourche with Bordeaux mixture 4-4-50, distillate 1-100 (used as a 'sticker'), and nicotine sulphate ('Blackleaf 40') 1-1000, applied in varying combinations at weekly intervals. At Baton Rouge the bulbs were imported from the regions subject to disease, but all the plants remained healthy throughout the season. The solutions containing distillate were better than Bordeaux mixture alone, being less easily washed off by rain.

In the Bayou Lafourche region a weekly spraying was not sufficient to protect the onions from black stalk rot and other

diseases, and the extra yield obtained did not justify the expense of the treatment.

A further series of tests with bulbs procured from different districts showed that the yield at Baton Rouge was nearly double that obtained in the alluvial region of Lafourche, and the author, therefore, recommends that seed for the market should be grown as much as possible outside the lower coast region.

Destructive Insect and Pest Act Advisory Board, Canada.

A Destructive Insect and Pest Act Advisory Board has recently been established in Canada to supervise the carrying out of the provisions of the Act, and to recommend to the Minister of Agriculture such changes or additions in the regulations as may be deemed necessary. The appointment of the following as members of the first Board was notified on 5th May, 1922:—Arthur Gibson, Dominion Entomologist, Chairman; E. S. Archibald, Director of Experimental Farms, Vice-Chairman; J. H. Grisdale, Deputy Minister of Agriculture; H. T. Güssow, Dominion Botanist; and L. S. McLaine, Chief, Division of Foreign Pests Suppression, Secretary.

Amendment No. 1 to regulations governing the importation of Potatoes into the United States.—*U.S. Dept. of Agric. Fed. Hort. Board*, June, 1922.

By this amendment, which is effective from 20th June, 1922, special provision is made for the importation of potatoes from foreign countries into Hawaii and Porto Rico; they are admitted for local use only, free of any restrictions.

Potatoes may be imported from the Dominion of Canada and from Bermuda into the United States free of any restrictions. Potatoes from certain districts of Mexico may be imported into the United States under certain conditions and restrictions, which are detailed.

Plant Pest and Disease Ordinance, 1921 (No. 38 of 1921): Regulations. Dar-es-Salaam, Tanganyika, 9th June, 1922.

The Plant Pest and Disease Destruction Regulations, 1922, provide for the destruction by fire of any plant in Tanganyika Territory declared to be a pest under the Plant Pest and Disease Ordinance, 1921. The following are declared to be pests within the meaning of the Ordinance: Mistletoe (*inter alia Loranthus* spp. and *Viscum* spp.); Dodder (*Cuscuta* sp.).